Power and The Engineer

Vol. 32 NEW YORK, DECEMBER 20, 1910 No. 51

IMAGINE a case like this: A young man is given a good education which includes a thorough training in all the branches of mathematics. After acquiring this, his activities are such that he has absolutely no occasion to make any use whatever of his mathematical equipment for, say, fifteen years. Then suddenly he is called upon to apply some of the more advanced portions of the training which he had received.

How well do you suppose he would succeed? Remember, he has not used his knowledge for fifteen years!

Would it be reasonable to expect that he would do other than fall down hard?

The odds are a thousand to one that he would fail.

Again, take the case of an athlete—a runner, for instance. After several months of training, say he is able to get himself into condition to negotiate a mile in four and a half minutes. Then, he goes out of training and does not do any running for two or three months.

Put him in a "real" race, and he would make a fool of himself.

In steam engineering—in fact, in any line of endeavor the same causes produce the same effects.

Inaction is death!

The minute that you begin to stand still, your power and value begin to go back.

* * * * *

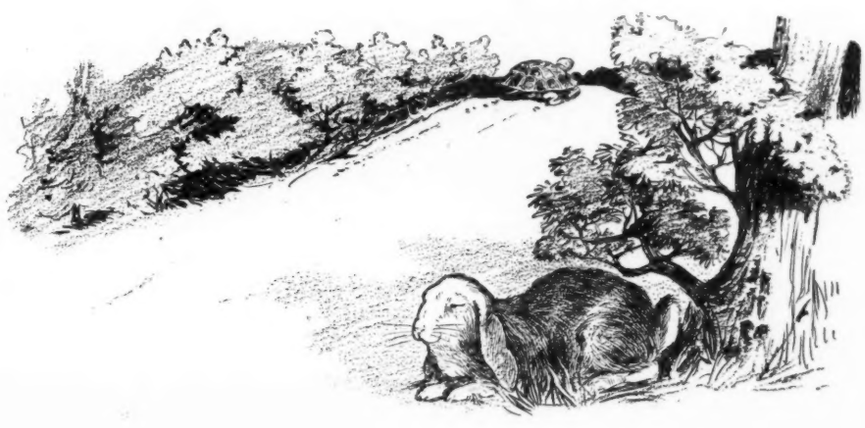
What the world wants is not so much to be informed as to be reminded. Therefore, this time, be reminded of some of the lessons taught by that venerable allegory concerning the hare and the tortoise.

Because a man is "swift," that is to say, has special ability, he has no license to go to sleep on his job. In order to reap the fruit which special ability should bear, a man must cultivate his ability. The way in which to cultivate it is to make use of it.

Many, many men fall serenely to sleep with the conceit that they are hares and wake up too late, only to discover that after all they were merely tortoises. In a word, over confidence often explains a man's lack of success.

The use of ability, be it of the ordinary or of the special kind, creates more ability.

Thus, the benefit is twofold: the profits that must accrue from the employment of the ability already possessed, and the acquisition of more ability.



To open the way for more opportunities, make the right use of those which you now possess.

Western Union Plant in Chicago

By Osborn Monnett

A plant furnishing power for a system of independent electric drive in connection with all the machines of a large printing establishment. One of the most interesting features of the installation is the coal-handling apparatus.

The Western Newspaper Union, of Chicago, which does a general printing business on a large scale, has lately moved into its new building at the corner of Clinton and Adams streets. This building is of modern fireproof construction and contains its own power plant which furnishes power for the work done by the company, motor drive being installed on all presses and other machines. The general layout of the plant is shown in Fig. 5. Referring to this, it will be noticed that there is an unusually large coal-storage capacity, this space being an areaway under the alley at the rear of the building. Provision for the storage of approximately 350 tons of coal is thus made without taking up any ground space of the building itself.

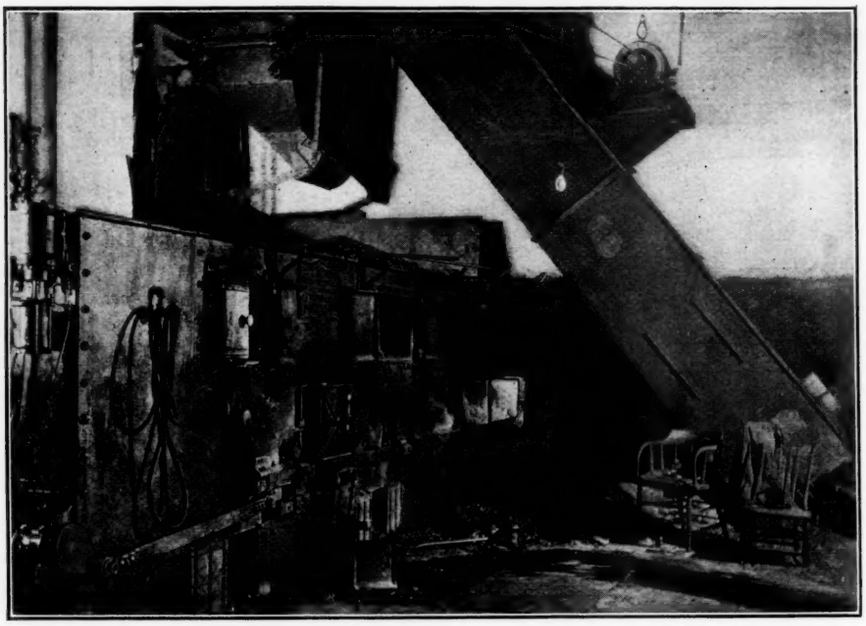


FIG. 1. FRONT OF BATTERY, SHOWING CONVEYER

BOILER-ROOM EQUIPMENT

The boiler room contains three boilers of the Atlas type, two of which are installed in a battery and one in a single setting. Each contains 1740 square feet of heating surface and is fitted with a Model stoker, having a grate 5 feet 6 inches by 6 feet, giving a ratio of grate to heating surface of 1 to 53. Although somewhat unusual in a plant of this size, a complete coal-handling apparatus has been installed. The conveyer, as shown in Fig. 1, is of the Jeffrey type, consisting of a short covered motor-driven bucket elevator, into which the coal is dumped on a level with the boiler-room floor and discharged into a traveling weighing hopper, distributing the coal to any one of the three stokers. It is capable of delivering coal at the rate of 15 tons per hour, each hopper holding one ton. Of course, ordinarily the coal will not be used at anywhere near the maximum rating of the bucket elevator, but this rate becomes of value in case coal is needed quickly at any one point; therefore, the rating of the machine bears no special relation to the amount of coal that is burned per hour.

The ashes are dumped from the ash-pits into a telescopic ash hoist by means of which they are deposited into wagons in the alley overhead.

In connection with the stokers, which are driven by small steam engines, there has been installed a Spencer damper regulator, arranged not only to operate the dampers but also to control the speed of the stoker drive and thus regulate the feeding of the coal according to the load requirements. This permits the operation of the plant under practically smokeless conditions regardless of the load. The gases discharge into a breeching back of the boilers through which they pass to the base of the stack, which is 5 feet in diameter and 150 feet high. Vulcan soot blowers make it possible to clean the soot from the tubes by opening a steam valve on each boiler. On a recent test a boiler and furnace efficiency of 70.29 per cent. was obtained when using a coal having a heat value of 11,150 B.t.u.

PUMPS

In the boiler room there are two duplex pumps and one motor-driven triplex pump, the latter being used to handle the feed water during the summer. Either of the duplex pumps may also be used for this purpose, and, in fact, the three pumps, as shown in Fig. 2, are interconnected so that any one may serve as a feed pump or house pump. From the pumps an extra-heavy pipe is run to a manifold at the side of one of the boilers, from which point the feed is controlled.

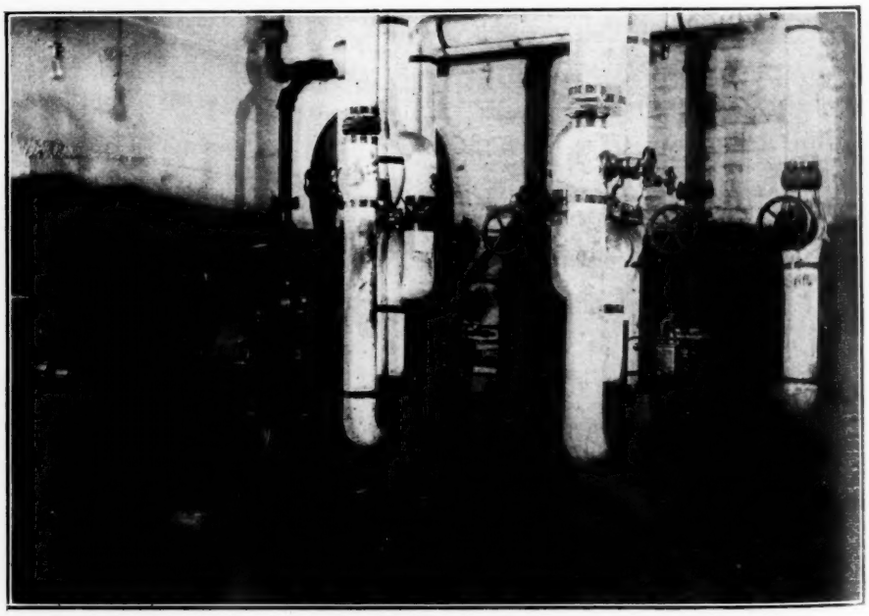


FIG. 2. FEED PUMPS

Connecting with this manifold is also a pipe from the city-water supply so that any boiler may be filled conveniently after being washed out. Two permanent feed-water weighing tanks make possible at any time a determination of the evaporation of any or all of the boilers.

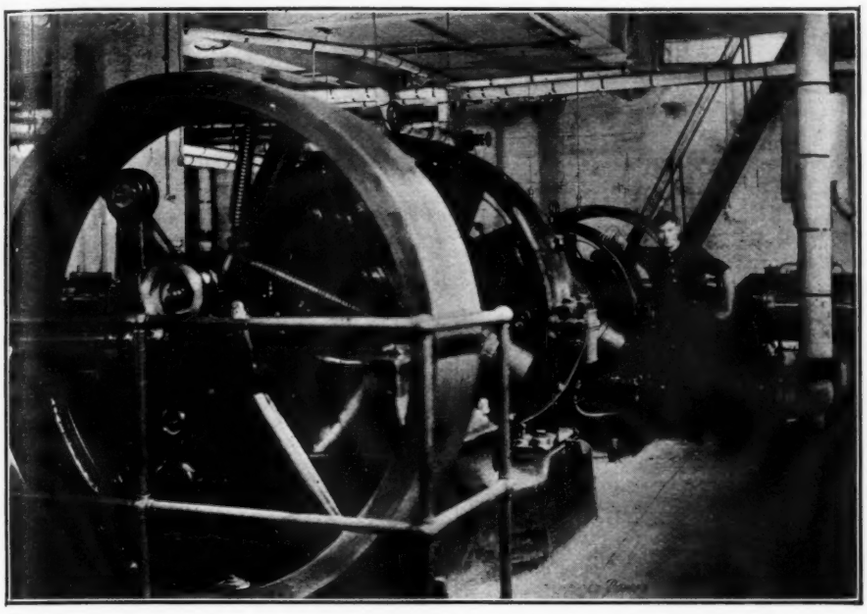


FIG. 3. VIEW OF SMALL UNITS

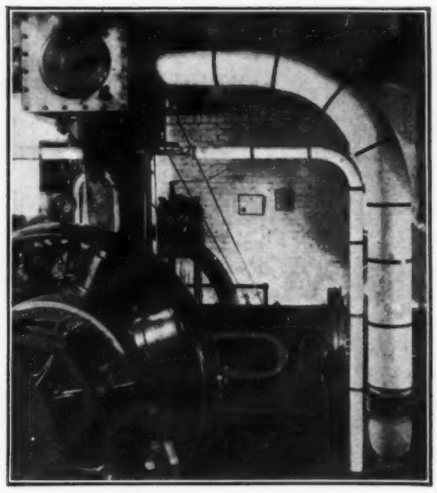


FIG. 4. ANGLE-COMPOUND UNIT

PIPING

From the boiler nozzles the steam passes into 6-inch Lagonda automatic stop and check valves, thence into the steam header through long-radius bends and globe valves. The header extends from a point over the boilers straight into the engine room, where it terminates in a 10-inch steam main, out of the top of which the several branches to the engines are taken, the steam first passing in each case through a separator located directly above the engine throttle. The exhaust lines rise from the engines to a 10-inch exhaust header located overhead and after passing through an oil separator and after passing through the engine the steam enters an 8-inch heating main which connects with the radiators throughout the building, having a Webster vacuum return. There is also a 12-inch main exhaust line passing to the roof in which is placed an atmospheric relief valve. Tapping the main exhaust directly after leaving the oil separator is an 8-inch connection leading to the feed-water heater. Also at this point there is a 5-inch connection to a heater, through which the building receives its supply of hot water. The piping is all extra heavy with screwed flanges. Both the live- and exhaust-steam lines are well drained at every point where condensation is liable to occur, the several branches leading into a trap, in the case of the high-pressure lines, from which point the condensation is discharged to the drip tank to be used over again. The exhaust lines are also drained by traps discharging to the drip tank or sewer.

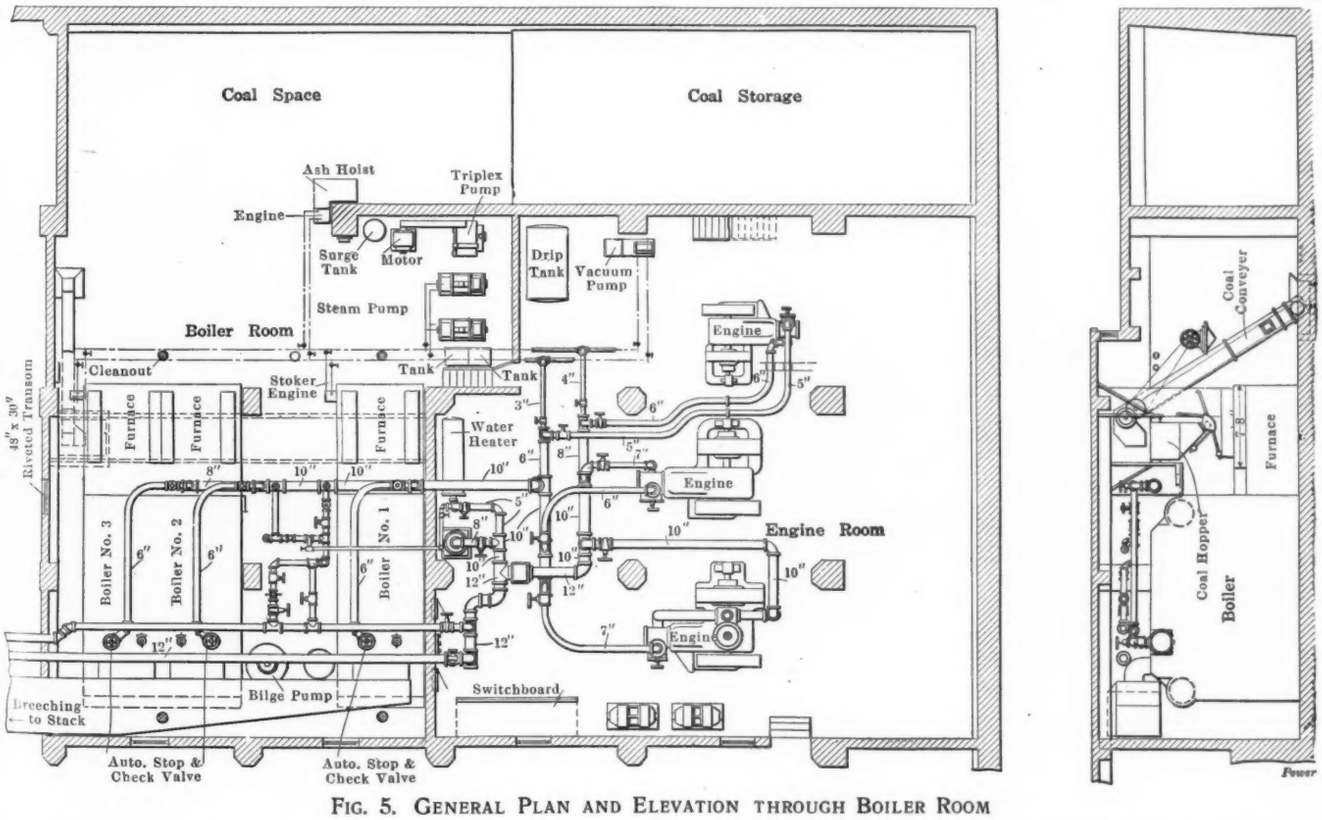


FIG. 5. GENERAL PLAN AND ELEVATION THROUGH BOILER ROOM

Engine Room

Three American-Ball generating units are installed having rated capacities of 200, 120 and 75 kilowatts. The engine of the largest unit, shown in Fig. 4, is of the angle-compound type, 17 and 28 by 14 inches and runs at 260 revolutions per minute. The engines driving the other two generators, see Fig. 3, are of the simple horizontal type, one 16x16 inches and the other 14x12 inches.

Direct current is delivered on the two-wire system at 230 volts, and duplicate compensating sets, each of 15 kilowatts capacity, are used to supply lighting current at 115 volts. These compensating sets are arranged to be run in parallel when necessary.

About one hundred and sixty motors are now in use, ranging from ⅛ to 12 horsepower. Adjacent to the switchboard there is a gage board for the three boilers, enabling the operator to have command of the entire plant from this point.

The lighting and power circuits throughout the entire building are in exposed conduit. This is unusual in a concrete building, where the ordinary method is to conceal the conduits in the concrete as the construction progresses. This system makes it possible to add to or subtract from the circuits without destroying the general plan.

The entire plant was designed and its construction supervised by Charles G. Atkins, consulting engineer.

The Steam Turbine in Germany

By F. E. Junge and E. Heinrich

A comparison of the Rateau and Curtis principles of turbine construction. The authors also present a simple method of estimating steam velocities in the blades, force exerted in the direction of blade travel, and "indicated" efficiency of energy conversion, by means of triangles.

Steam Velocities and Critical Pressure Ratio

If the ratio of pressure before the stage to pressure behind the stage exceeds 1.83 with superheated steam or 1.73 with saturated steam, then conically diverging nozzles must be employed. This obtains as a rule for Curtis turbines working with steam velocities between 2000 and 3000 feet per second. If the pressure ratio remains below the critical value stated, as is the case with the Rateau-Zoelly type, then orifices with parallel walls are used for the guiding apparatus. In contradistinction to Curtis, Zoelly and Rateau employ steam velocities of from 1000 to 1600 feet per second.

The Curtis and Rateau Principles

The main arguments for and against the two types, as generally propounded by the representatives of the respective systems, are as follows: In favor of the Curtis principle is argued extensive expansion of the steam in the first stage, therefore low pressure and low temperature in the casing, whereby the turbine becomes less sensitive to varying temperatures. Further, comparatively little pressure upon the high-pressure stuffing box, hence small leakage losses. Moreover, reduction of axial length of turbine and therefore low cost per horsepower. Finally, the possibility of power regulation by increasing or decreasing the number of nozzles which are active in the first stage.

To the high-pressure part built according to the Rateau principle the objection is offered that the full initial temperature of the admission steam enters the casing, that the stuffing box has to stand a comparatively high pressure and that therefore the leakage losses through the high-pressure stuffing box are accordingly high. Further that the losses due to leakage between the various stages, especially in the high-pressure part, are considerable and have an unfavorable effect on steam consumption.

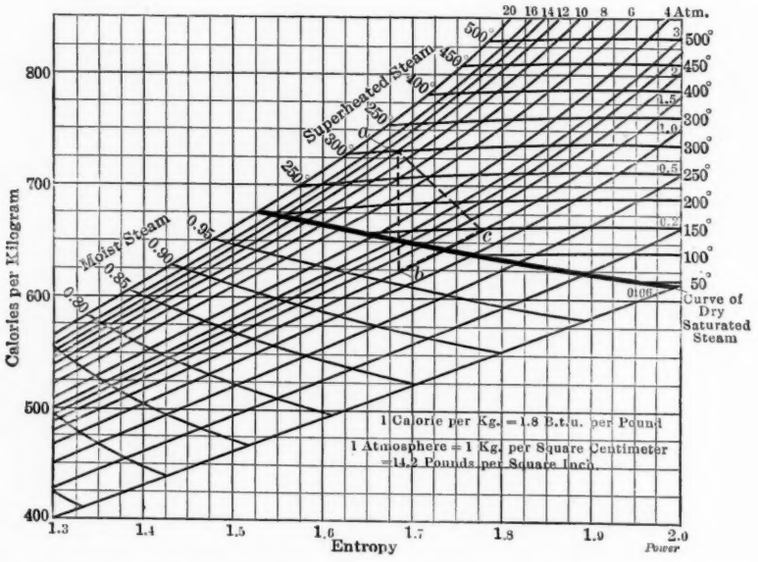

Calories per Kilogram
Entropy
Superheated Steam
Moist Steam
Curve of Dry Saturated Steam
1 Calorie per Kg. = 1.8 B.t.u. per Pound
1 Atmosphere = 1 Kg. per Square Centimeter = 14.2 Pounds per Square Inch

Fig. 6. Mollier Diagram; Energy Theoretically Available in Steam

On the other hand, the Rateau advocates offer the objection to the Curtis principle, notwithstanding affirmations to the contrary, that the high steam velocity with which the wheel has to work has in the course of time a destructive effect upon the blades and therefore also an unfavorable effect on the steam consumption. This is said to be especially the case when the turbine works with low superheat and if the Curtis wheel is employed also in the low-pressure part of the turbine; for it is known that the destructive effect of the steam jet increases with the moisture content of the steam. It is further stated, on the basis of results obtained in practical operation, that in impulse turbines the higher temperature of the steam entering into the casing can cause no appreciable difficulties if suitable construction be employed. Also, that reduction of axial length has been attained by recent improvements of design, providing a smaller number of stages; that the high-pressure stuffing box can be kept perfectly tight by employing a modern arrangement of carbon-packing rings, consisting each of two or three segments, and, finally, that regulation by nozzles, or devices for varying the number of active nozzles in the first stage, can be employed in the Zoelly turbine.

The Mollier Diagram

Before entering into the special discussion it is advisable to get clear about the fundamental ideas and methods of investigation. Without taking recourse to theoretical explications we will set forth the practical application. Fig. 6 is the Mollier diagram for determining the available energy in steam under different conditions. The present form of the diagram covers the pressure, temperature, heat content and specific weight of the steam. In newer forms of the Mollier diagram the curves of specific volume are added to the above, but they are omitted here in order not to complicate the presentation. If only two values, for example the temperature and pressure of the

steam, are given, then all the others can be read from the diagram. All values are, of course, based on unit weight of steam. The ordinates of the diagram represent the total heat content of a kilogram of steam and the abscissas the entropy of the steam, which, of course, remains constant with adiabatic expansion. As the entropy values are represented by the abscissas an adiabatic change of condition is represented by a vertical line in the diagram. Having to utilize in the turbine the drop of heat energy between a certain initial and a certain final pressure, in order to obtain the energy theoretically

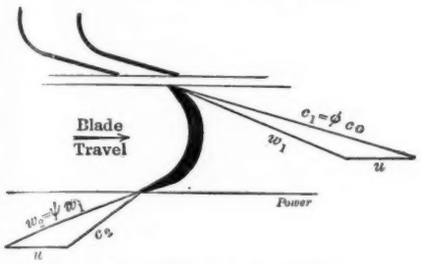


FIG. 7. VELOCITY TRIANGLES

available in an ideal engine, it is only necessary to trace along a vertical line from the point of initial pressure to the point where the line intersects the curve of the final pressure, and then read the difference between the initial and final heat content from the diagram.

For instance, if steam of 12 kilograms per square centimeter (171 pounds per square inch) at 300 degrees Centigrade is to expand down to 1.5 kilograms per square centimeter (21.4 pounds per square inch) absolute pressure, what is the theoretically available energy per kilogram of steam? The initial point a of the process is located by the intersection of the 12-kilogram curve and the 300-degree curve. The vertical line drawn from the point a meets the pressure curve 1.5 at the point b. Then, from the left-hand scale, the heat content per kilogram at the point a is 730 calories and at the point b, 625 calories. Hence, the available energy is 105 calories per kilogram, or 189 B.t.u. per pound of steam.

LOSSES

In actual steam-turbine practice losses occur by friction, shock and eddy currents of the steam, which are transposed into heat. This heat cannot disappear and so is added to the original heat in the steam. Therefore during the whole course of the process heat is added to the working fluid. Hence, the expansion will not end at the point b but at a higher point, as at c, of the pressure curve, the vertical distance between the two points representing 37 calories equals 66.6 B.t.u. per pound, which represents the total amount of these losses. The heat balance comes out as follows: available energy, 189 B.t.u.; losses, 66.6 B.t.u.; utilized energy,

$$189 - 66.6 = 122.4 \text{ B.t.u.}$$

Hence the efficiency of the process is

$$\frac{122.4}{189} = 0.647$$

or practically 65 per cent.

As this figure covers only those losses which are imparted to the steam in form of heat and does not include the exterior heat and mechanical losses, it is usually called the "internal efficiency." But it affords a fair measure of comparison between two turbines.

THEORETICAL HEAT DROP AND THEORETICAL VELOCITY OF ISSUE

To the theoretically available energy, which may be called h_0 per pound, corresponds the theoretical velocity of issue, c_0. In order to establish a relation between the two the energy values must be expressed in the same units. As the mechanical equivalent of a B.t.u. is 778 foot-pounds, h_0 B.t.u. represent 778 h foot-pounds. To the velocity c_0 corresponds an energy value of $\frac{c_0^2}{2g}$ foot-pounds per pound of steam. In this expression $g = 32.16$ feet per second, the acceleration by gravity. Hence we have the equations of energy

$$\frac{c_0^2}{2g} = 778\, h_0$$

and

$$c_0 = 223.7 \sqrt{h_0}$$

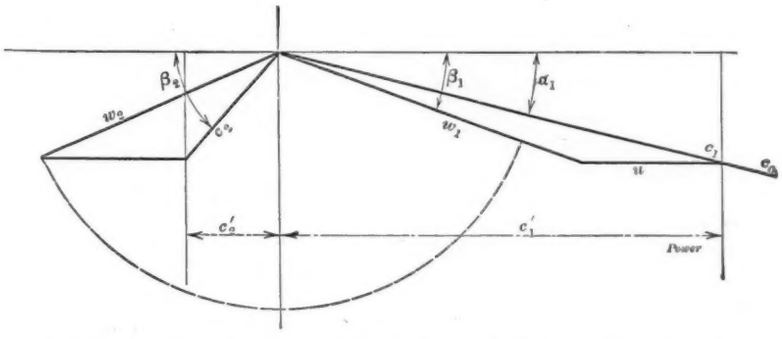


FIG. 8. DIAGRAM FOR IMPULSE WHEEL WITH ONE VELOCITY STAGE

VELOCITY TRIANGLES

Owing to the losses occurring in the guiding apparatus the steam issuing from that apparatus has not the ideal velocity c_0, but a lower velocity, $c_1 = \phi\, c_0$, ϕ being the coefficient of loss in the guiding apparatus. Fig. 7 shows the velocity triangles for the entrance into and exit from the moving blade, by the steam. Now, in determining what is the velocity of flow of the steam in the blade channels, one must bear in mind that the blades are not at rest, but travel with the velocity u per second, which is the circumferential velocity of the wheel. But since, on the drawing board, we must represent the blades as stationary, it is necessary in order to get at the entrance velocity into the blade—the so-called relative entrance velocity—to go back in the opposite direction from the end of the velocity line c_1 by the amount u. This locates the end of the line w_1, which represents the velocity of the steam relative to the blade at the entrance. When the steam passes through the blades, losses occur through friction, shock and eddy currents, so that the relative exit velocity $w_2 = \psi\, w_1$, wherein ψ is the coefficient of loss in the rotating blades.

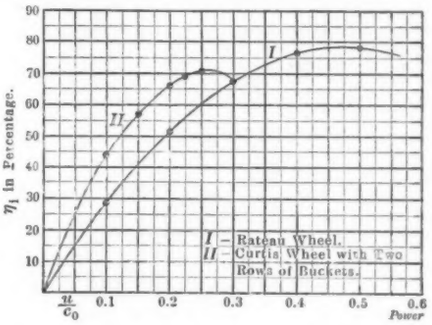


FIG. 9. CURVES OF INDICATED EFFICIENCY

In order to get from the relative outlet velocity w_2, the absolute outlet velocity c_2, it is necessary again to consider the movements of the blades and this time to advance from the end of the vector w_2 in the direction of the blade travel by the amount u. This locates the end of the line representing the absolute velocity of issue c_2. In Fig. 8 we have combined the two velocity triangles as it is generally done in practice.

DETERMINATION OF INDICATED EFFICIENCY

Indicated efficiency ηi is the ratio of the work transmitted to the blades to the theoretical work. The losses which are accounted for in this expression are only those in nozzles and blades. By changing the direction of flow and the magnitude of absolute velocity when traveling along the curve of the blade, the steam exerts a force which acts in the direction of the movement of the blades. Now the question presents itself, how large is the impelling force of the deviated steam? Before answering this question we must refer to the elementary law of mechanics which establishes the relation between force, mass and change of velocity within the unit of time (ac-

celeration and retardation). According to this law, force = mass × acceleration. If the acceleration is positive, that is to say, if the velocity increases, then the force is imparted to the mass. If the acceleration is negative, the movement of the body being retarded, as is the case with the steam in our example, then the mass supplies the force.

In order to determine the change of velocity per second, the components of the absolute entrance velocity vector c_1 and the absolute exit velocity vector c_2 in the direction of blade movement are plotted as shown in Fig. 8. The sum of the two projections, $c_1' + c_2'$, obviously represents the change of velocity per second. The mass of one pound of steam is $\frac{1}{g}$. Hence one pound of steam has imparted to the blades the force

$$P = \frac{1}{g}(c_1' + c_2')$$

and, since u = travel per second, the work done by unit weight of steam is

$$w = P\,u = \frac{u}{g}(c_1' + c_2')$$

As was mentioned above, the available energy contained in one pound of steam working in an ideal engine is $\frac{c_0^2}{2g}$. Therefore, the indicated efficiency is

$$\eta_i = \frac{\frac{u}{g}(c_1' + c_2')}{\frac{c_0^2}{2g}} = \frac{2\,u\,(c_1' + c_2')}{c_0^2} \qquad (1)$$

If h_o represents the available energy per unit of weight in heat units, $\eta_i\, h_o$ is the energy transmitted to the blades, and

$$R = (1 - \eta_i)h_o \qquad (2)$$

is the loss in nozzles and blades. If η_i is to be determined for various velocity conditions, the velocity diagrams are drawn on the board, c_1' and c_2' are obtained from the diagram and η_i is calculated from formula 1. When doing so, it is advisable to vary the ratio $\frac{u}{c_o}$ (blade velocity to theoretical velocity of issue), which determines the value η_i. If c_o is taken equal to the unit of length, then the denominator of the fraction in equation (1) becomes 1 and the efficiency appears simply as twice the product of the two factors u and $(c_1' + c_2')$. In Fig. 9 we have drawn the η_i curve for various values of $\frac{u}{c_o}$. It is evident that the efficiency η_i increases with the ratio $\frac{u}{c_o}$ up to a certain maximum value, which for Rateau wheels lies in the neighborhood of 0.5.

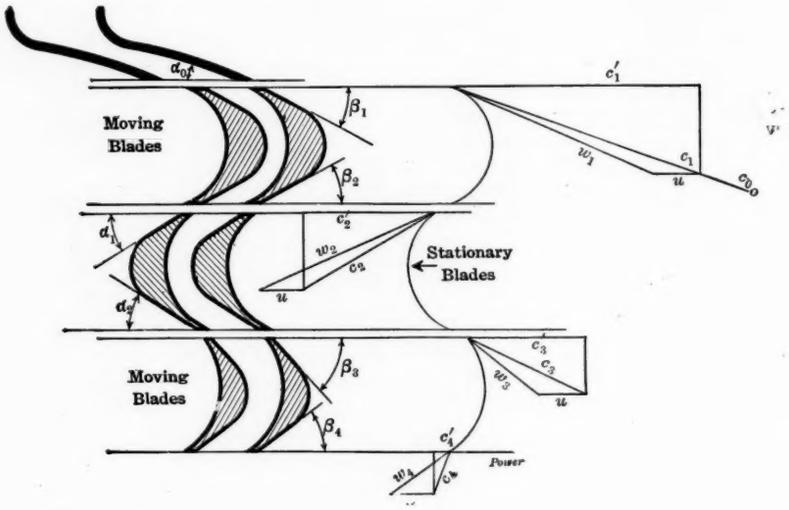


FIG. 10. VELOCITY DIAGRAM FOR CURTIS BLADING

APPLICATION TO TWO ROWS OF BLADES

If the velocity c_2 at which the steam leaves the first row of moving blades is still high enough, it is utilized in a second row of blades, which are fastened on the same wheel disk. For this purpose the direction of the flow of the steam must be so controlled by an intermediary row of stationary blades that it impinges upon the blades of the second row in a manner yielding the highest efficiency. Fig. 10 shows such a combination of blades. The indicated efficiency is determined in the manner just described for one row of blades. We must therefore add in the numerator of the fraction in equation (1) to the indicated work transmitted to the first row of moving blades the work transmitted to the second row. Thus, if c_3 and c_4 are the entrance velocities into the second row of moving blades, and c_3' and c_4' the components of these velocities in the direction of blade movement, the following simple expression is obtained for the Curtis wheel:

$$\eta_i = \frac{2\,u\,(c_1' + c_2' + c_3' + c_4')}{c_0^2} \qquad (3)$$

wherein c_o is again the ideal velocity of issue corresponding to the entire drop of energy h_o. Fig. 9 contains, besides the efficiency curve for one velocity stage, the curve for two velocity stages, for special conditions.

SPECIAL FEATURES OF THE CURTIS PRINCIPLE

In accordance with what was said of the Curtis principle in our first article (POWER for November 8) we repeat that the efficiency of the Curtis blading may be increased by not expanding down to back pressure in the nozzle but converting a certain fraction of the energy drop in the first row of rotating blades. With this practice it is, however, not possible to avoid a certain leakage loss, because within the first blade channel the pressure is higher than without. Assuming that h_2 heat units are transferred into velocity energy in the first row of moving blades and that the losses occurring therein are ξ per cent. of the energy $\frac{w_2^2}{2g}$, which is represented by the relative velocity of issue, this energy must be equal to the energy which corresponds to the relative entrance velocity plus the energy $778\,h_2$ converted in the blade channel, minus the losses in the blade channel $\frac{\xi}{100}\frac{w_2^2}{2g}$. Therefore,

$$\frac{w_2^2}{2g} = \frac{w_1^2}{2g} + 778\,h_2 - \frac{\xi}{100}\frac{w_2^2}{2g}$$

and

$$w_2 = \sqrt{\frac{w_1^2 + 2g\,778\,h_2}{1 + \frac{\xi}{100}}} \qquad (4)$$

The total number of newspapers published in the world at present is estimated at about 60,000, distributed as follows: United States and Canada, 23,461; Germany, 8049; Great Britain, 9500; France, 6681; Japan, 1000; Italy, 2757; Austria-Hungary, 2958; Asia, exclusive of Japan, 1000; Spain, 1000; Russia, 1000; Australia, 1000; Greece, 130; Switzerland, 1005; Holland, 980; Belgium, 956; all others, 1000. Of these more than half are printed in the English language.

The White Star liner "Olympic" will be fitted with two sets of reciprocating engines for driving the outer screws, while a third screw, placed centrally, will be actuated by a low-pressure turbine, served by the exhaust steam from the rotary sets. She and her sister vessel, the "Titanic," are considerably larger than the "Lusitania" and the "Mauretania," but not so speedy. Their length overall is something like 100 feet greater than the Cunarders, and their horsepower 46,000, as compared with the others' 70 000.

Test of a 10,000-Kilowatt Turbine*

By Samuel S. Naphtaly

This unit, consisting of a double-flow, combined impulse and reaction turbine connected to a three-phase, sixty-cycle generator, installed in the plant of the City Electric Company of San Francisco, showed a water rate of approximately 13.5 pounds per kilowatt-hour at full load.

The object of the test was to determine the steam consumption of the turbine under normal operating conditions and further to determine whether the builder's guarantees of economy, generator temperature, etc., had been complied with. The specifications called for a turbine of 10,000 kilowatts normal capacity with an additional overload capacity of 50 per cent., operating at 175 pounds gage pressure, and 100 degrees superheat with a 28-inch vacuum, measured in the exhaust. Under these conditions, when running at 1800 revolutions per minute, the guaranteed performance was as follows:

Full load, 10,000 kilowatts, 14.3 pounds of steam per kilowatt-hour.

One-half load, 5000 kilowatts, 16.2 pounds of steam per kilowatt-hour.

Fifty per cent. overload, 15,000 kilowatts, 15.3 pounds of steam per kilowatt-hour.

The turbine was of the double-flow type, containing both impulse and reaction elements, a section of which is shown in Fig. 1. The governing apparatus presented no particularly novel features, there being two governor-controlled inlet valves, each admitting steam to a group of nozzles, with full load carried on the primary valve alone. Overloads were maintained by a group of nozzles operated by the secondary valve. These valves were hydraulically operated, oil under pressure being supplied by the oil pump driven by the turbine. The operation of the hydraulic gear was accomplished by the familiar relay and floating lever. Hitherto, it has been customary to construct the relay for a mechanism of this character without lap; or if it does have lap, either negative or positive, the amount of this lap must be traveled before the mechanism can respond to the governor. A departure was made in this machine from previous practice by providing the relay plunger with both inside and outside laps, the relay being kept oscillating a small amount by means of a cam connected to the governor linkage, sufficiently to uncover slightly the ports at each oscillation, and causing a correspondingly slight motion of the main operating piston. The effect of the governor itself on this relay, is, of course, to change its plane of motion, insuring a response to the least change in position of the governor weights.

The generator was a three-phase, sixty-cycle machine having a normal rating of 525 amperes at 11,000 volts. The field was of nickel steel and made up of two halves joined end to end by shrink links. Each half was integral with its shaft, rendering any hole for the shaft unnecessary and consequently considerably increasing the strength of the revolving field.

All important readings were taken at five-minute intervals except in cases of energy output and water measurement, for which fifteen-minute intervals proved adequate. The electrical output was obtained with a polyphase wattmeter, and the steam-consumption measurements were made by actually weighing the water discharged from the surface condenser.

Tests were made for leakage of the cooling water (salt water) into the condenser by adding silver nitrate to samples of the condensed steam but no indications of leakage were found. The shaft glands were sealed by water taken from the condenser discharge before weighing and the leakage from the outside of the glands was caught and measured. In this way no special allowance was necessary for gland-sealing water. The stuffing boxes of the centrifugal hotwell pumps were sealed with water from the discharge. A small leakage occurred here which was caught and added to the leakage from the main unit gland. All pipes connected with the condenser or piping system, by which water might escape from the discharge or leak into the discharge water, were disconnected, blanked or arranged with two valves with an opening between for detecting leakage. Observations were made of the pressure and temperature of the steam at the throttle, pressures within the turbine at the inlet, intermediate and low-pressure points. The vacuum was indicated by a mercury column and the atmospheric pressure by a mercury barometer.

A summary of the test is given in Table 1. During the high-load tests, this was the only unit operating in the station, so that observations had to be made under the load variations incidental to station operation. In all, seven runs were made, two of which, *E* and *G*, were at low vacuums for the purpose of establishing the effect of variations of vacuum on this machine. Both the thermal efficiency and that of the Rankine cycle

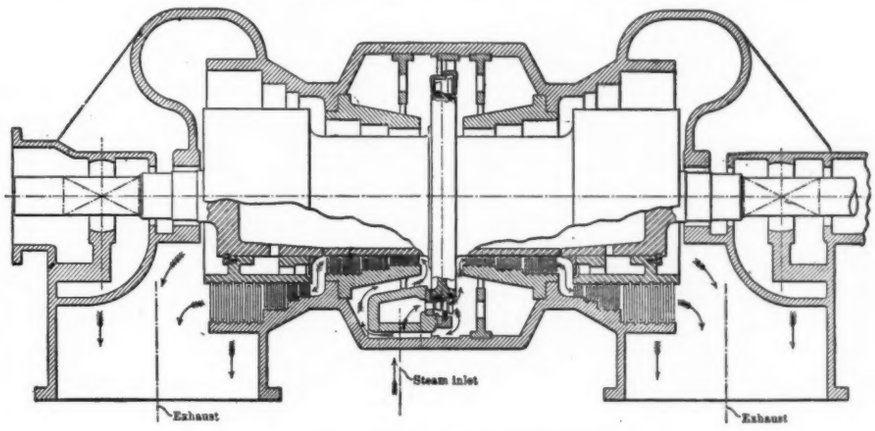


FIG. 1. SECTIONAL VIEW OF TURBINE

SUMMARY OF TEST.

Run.	Duration, Hours.	Actual Load, Kilowatts.	Power Factor, per Cent.	Steam Pressure, Pounds Gage.	Superheat, Degrees Fahrenheit.	Vacuum, 30 Inches.	Water per Hour, Total, Pounds.	Water per Kilowatt-hour as Tested.	Rankine cycle Efficiency as Tested.	Thermal Efficiency, per Cent.	Pound per Kilowatt-hour, Corrected 175 Pounds, 100 Degrees Superheat, 28 Inches Vacuum.
A	1.5	7,972	90	171	58	28.28	116,238	14.581	66.9	22.20	14.11
B	2.0	8,563	88	168	59	28.18	123,542	14.427	68.0	22.65	13.88
C	2.0	8,198	91	169	60	28.10	119,655	14.596	67.6	22.10	14.04
D	2.0	9,173	91	167	59	27.90	133,672	14.572	69.0	22.23	13.88
E	3.0	5,333	88	173	54	28.34	83,478	15.655	61.8	20.70	15.21
F	4.0	8,148	88	167	60	26.16	129,181	15.855	69.5	20.35	14.07
G	3.0	5,401	88	174	56	26.16	95,120	17.611	62.2	18.35	15.24

*Abstract of paper read before the American Society of Mechanical Engineers, December 6-9

were computed. The thermal efficiency considers only the heat in the steam from the boiler, and is of use only for comparing results with other forms of prime movers, such as internal-combustion engines. The Rankine-cycle efficiency, or efficiency ratio as it is sometimes called, is the more equitable measure for comparison of steam engines, as it deals with the work done between the limits of the steam leaving the boiler and the exhaust entering the condenser.

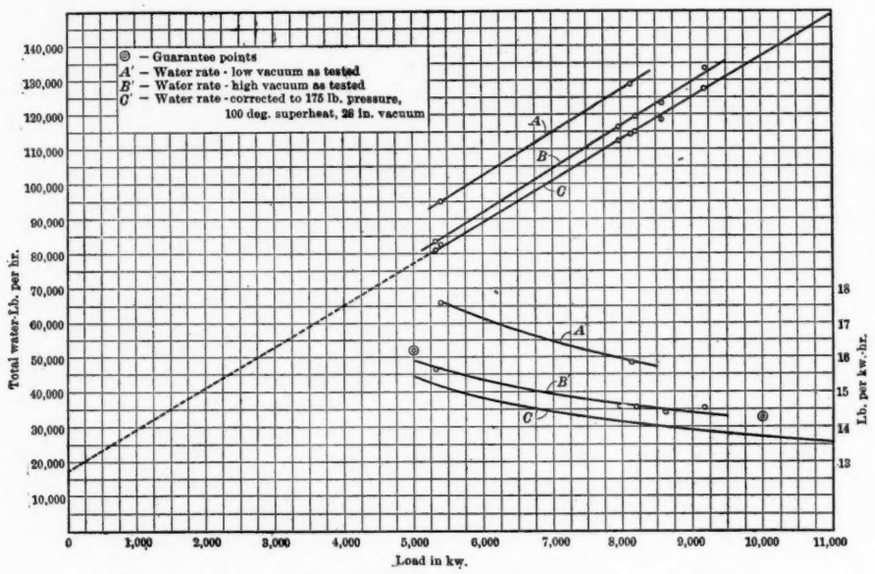

◎ — Guarantee points
A' — Water rate - low vacuum as tested
B' — Water rate - high vacuum as tested
C' — Water rate - corrected to 175 lb. pressure, 100 deg. superheat, 28 in. vacuum
Total water-Lb. per hr.
Lb. per kw.-hr.
Load in kw.
A
B
C

FIG. 2. ACTUAL WATER-RATE CURVES OBTAINED FROM TESTS

The water rates obtained during the test are plotted in Fig. 2. From these it is reasonable to expect that if a greater load had been available, the steam consumption would have further improved until the secondary valve opened. Allowing for a 10-pound drop through the inlet valves the load would have been approximately 11,000 kilowatts when a steam consumption of 13.7 pounds would have been obtained with an efficiency of 71 per cent.

CORRECTIONS

As the operating conditions specified by the contract, namely, 175 pounds gage pressure, 100 degrees superheat and 28 inches vacuum, could not be maintained throughout the test, correction factors had to be determined upon, and an agreement was reached previous to the tests as follows:

SUPERHEAT—One per cent. change in steam consumption for ten degrees in superheat, which is the correction factor commonly employed for turbines.

STEAM PRESSURE—One-half per cent. for each 10-pound change in pressure. However, as there was no reason for the full pressure not being maintained these were insignificant.

VACUUM—As the vacuum correction is affected by the design of the turbine, the amount of the correction could not be determined in advance of the tests; therefore runs *E* and *G* were made. From these and from the other tests it was found that 1 inch of vacuum affected the steam consumption 3 per cent. and 6 per cent. at full load and half load respectively.

Boiler Tube Soot Blowers

By Warren O. Rogers

Blowers fixed permanently in the boiler setting do the work quickly, and as effectually as by hand. They are always in place and ready for use. Several types of this class of tube cleaner, including those used for both return-tubular and water-tube boilers, are described.

Among the latest idea in soot blowers is that of arranging the device permanently in the brick setting in such a manner that the blower head is protected from the heat of the furnace when the tubes are not being blown. Quite a number of these devices have been designed.

The "Diamond" steam-flue blower belongs to the type that is permanently installed in the rear wall of the boiler setting, as shown in Fig. 1. It blows the soot in the natural direction of the draft to the front of the boiler and up the chimney. When not in use the nozzle is withdrawn into a sheath by the coiled spring in the handle to prevent injury from the heat. By rotating the handle the numerous jets of steam cover a circle 4½ feet in diameter. The work of cleaning can be carried on while the boiler is in operation. This device is made by the Diamond Power Specialty Company.

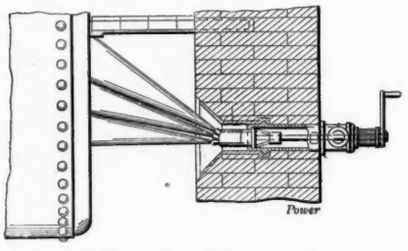


FIG. 1. "DIAMOND"

What is known as the "Henry" steam-flue cleaner is shown in Fig. 2. It is installed at the rear of the boiler and cleans with the draft, the soot being blown forward into the smoke-box extension and up the stack. The nozzle pipe, which covers one row of tubes at a time, is raised or lowered by means of the crank shown at the top. When not in use the head is drawn up close under the brickwork out of the direct path of the hot gases. Close contact is produced with each tube, and the tubes are cleaned in a few minutes. It is made by W. M. Sage.

Fig. 3 illustrates the "American" flue blower, made by Eugene J. Feiner. It is placed in the rear wall of the boiler setting, and may be operated from the rear or side walls. It blows with the natural draft of the boiler, and is arranged to blow a solid sheet of steam across the entire width of the boiler and directly into the tubes at the least possible angle,

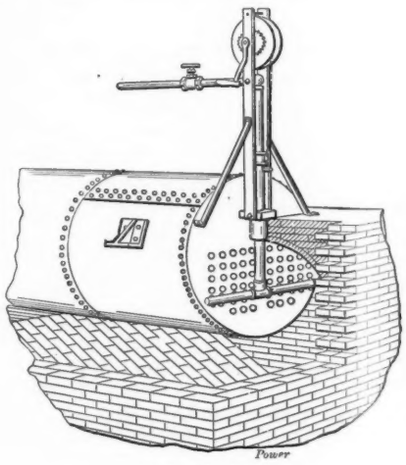


FIG. 2. "HENRY"

driving the soot forward to the smoke-stack.

The "U. S." tube blower, made by the U. S. Specialty Manufacturing Company, is shown in Fig. 4. It is a device for blowing soot out of boiler tubes

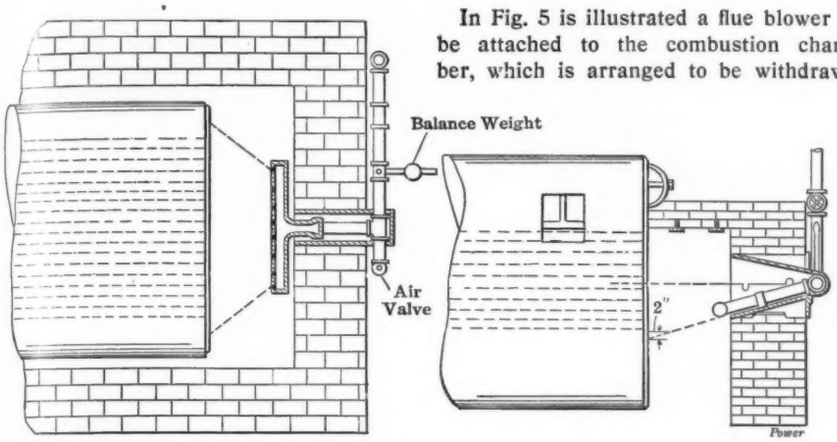


FIG. 3. "AMERICAN"

In Fig. 5 is illustrated a flue blower to be attached to the combustion chamber, which is arranged to be withdrawn with the draft. A casing passes through the rear wall of the boiler setting, and a T-shaped cast chamber outside the wall receives a 1½-inch supply pipe. Directly under this pipe in the chamber is a drain cock to dispose of the condensation, and on the end of the chamber is a stuffing box through which the handle rod passes to an inner tube which just fills the casing.

On the end of this tube is a hollow cast-iron arm, one-half the diameter of the boiler in length, having a 1/16-inch slot its entire length on the side toward the boiler. By pushing the rod endwise this arm is brought close to the rear end of the tubes into which the steam is delivered in a thin sheet. By means of a handle secured to a rod the arm is revolved so that the steam jets reach all of the tubes.

The blower can be used while the boiler is in operation, and when not in use the arm is pulled back and placed in a horizontal position on a shelf where it is not exposed to the heat from the influence of the hot gases when not in use. The device is made by the Zenith Manufacturing Company.

It consists of a hollow casting, with a packing nut at each end, through which moves a hollow rod having a handle attached. The inner member of the rod, which has a length equal to the radius of the tube sheet, is perforated with holes corresponding to the tubes of the boiler, and swings on a steam-tight joint. The steam enters the ports in the hollow rod and, by turning the handle, all the tubes are cleaned by a jet of steam, and the soot is blown out in the same direction as the draft of the boiler. When not in use all parts of the apparatus are removed from the influence of the heat and gases, and a disk on the end of the blower closes the aperture through which the swinging joint is inserted.

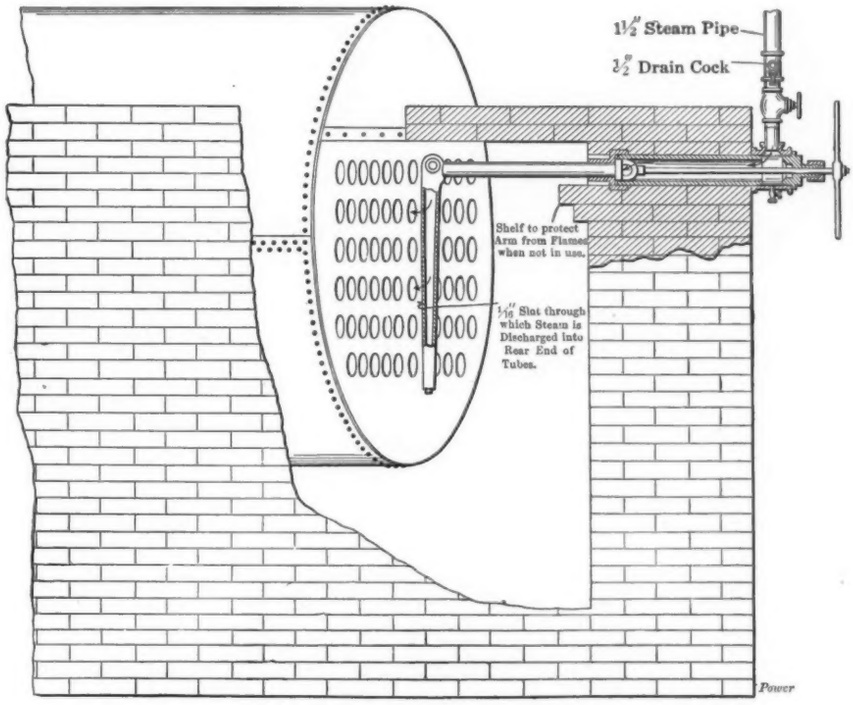

1½" Steam Pipe
½" Drain Cock
Shelf to protect Arm from Flames when not in use.
1/16" Slot through which Steam is Discharged into Rear End of Tubes.
Power

FIG. 4. "U. S." TUBE BLOWER

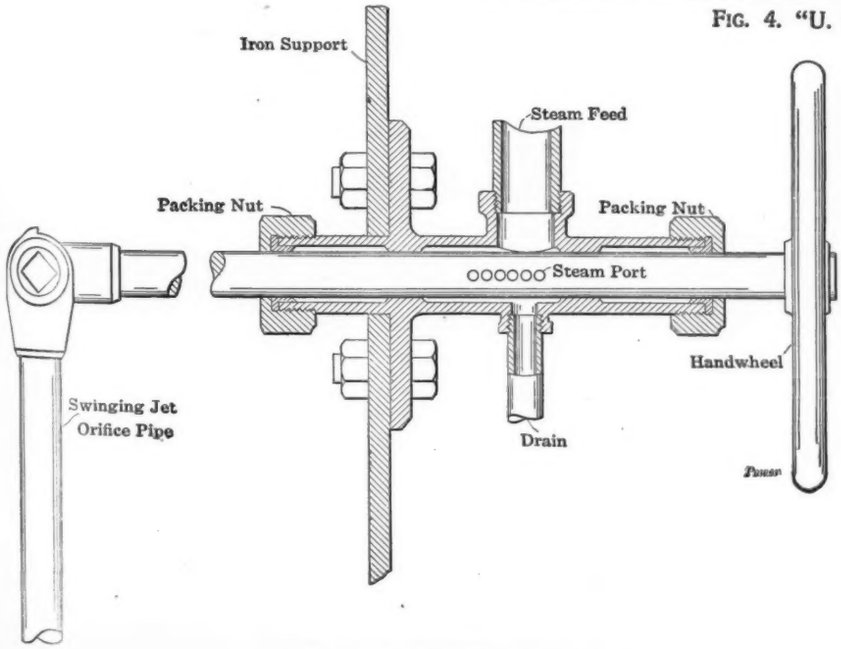


FIG. 5. ZENITH BLOWER

The "Marion" flue blower, made by the Marion Machine, Foundry and Supply Company, is shown in Fig. 6. The blower is a permanent fixture in the rear wall of the boiler setting and, as usual, blows the soot in the direction of the draft out through the chimney. The feature of the device is the rotating nozzle which has three, sometimes four, openings, according to the size of the boiler, these openings all pointing to a different section of the tube sheet. On the base of the nozzle casting is a flat valve seat on which a disk with one opening is held by the steam pressure. The disk may be rotated by a valve stem attached to the indicator on the handwheel, and thus each nozzle opening may be blown in turn. As the nozzle is rotated while each opening is being blown, all of the boiler tubes are cleaned.

Fig. 7 shows the heavy cast-iron cap which protects the nozzle from the fire. The blower is located opposite the center of the tube space, but not in the center of the boiler, and each one is constructed especially to fit the existing conditions of combustion space, firewall, etc., in different boiler settings, a nozzle being furnished which will insure the steam reaching all the tubes.

The "Monarch" boiler-tube blower is manufactured by the Monarch Steam Blower Company. It is shown in side elevation in the rear wall of a boiler setting in Fig. 8. The apparatus consists of an inlet pipe, a rear plug and a sleeve connecting with the plug and provided with a slot at its inner end and a valve seat. It also has a hollow valve stem with a cupped rear end forming a steam-tight connection with the valve seat in the sleeve when in operation; at its inner end the stem is provided with outlet apertures arranged at an angle to its axis.

Means are adopted to swing the inner end of the valve stem radially in the slotted end of the sleeve, also for rotating the valve stem. The shifting device consists of a fork and block operated by a shaft turned by a handle which carries a spring pin engaging at set points with counterborings on the rim of the handwheel, which indicate the particular row of tubes being cleaned.

In operation steam is admitted through the globe valve in the steam pipe, passes on to the rear plug *A*, Fig. 9, directly into the valve stem *B* and out of the aperture *C* into the boiler tubes, as shown in Fig. 8. The impact of the steam when admitted forces the seat *D* of the valve stem against the seat of the cylindrical sleeve, making a steam-tight connection and concentrating the entire boiler pressure through the aperture *C*, and then through the length of the boiler tube. After the operator has set the controller in one of the counterbore holes, the blower is rotated by means of a handwheel, after which the controller is shifted to the other counterbored holes in their order. Thus the blower revolves at each shift and blows steam through the entire number of boiler tubes.

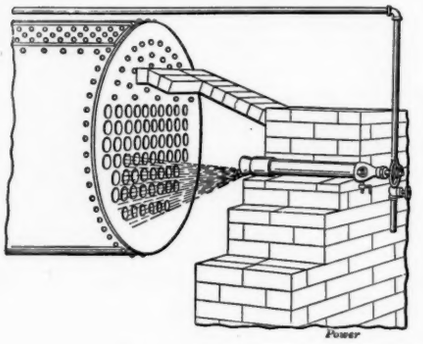


FIG. 6. "MARION"

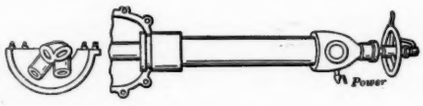


FIG. 7. MARION NOZZLE

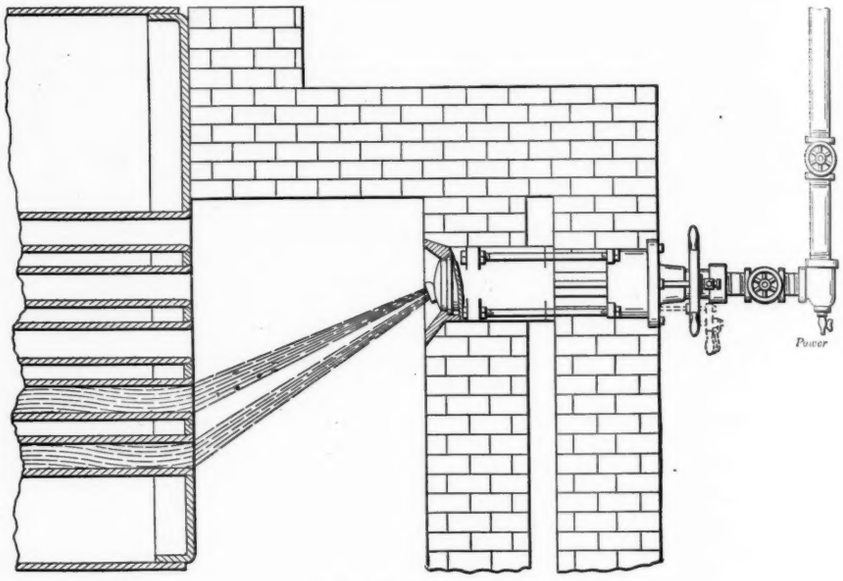


FIG. 8. "MONARCH"

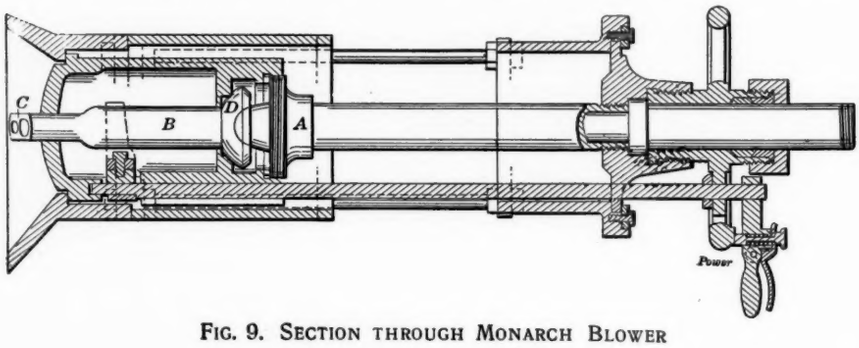


FIG. 9. SECTION THROUGH MONARCH BLOWER

The "Vulcan" soot cleaner, made by the Vulcan Soot Cleaner Company, is illustrated in Fig. 11. It is designed for cleaning the accumulation of soot from the heating surfaces of water-tube boilers. It is made up of an arrangement of stationary piping connected to a steam main and is installed on the side of the boiler setting.

It has twelve or more vertical branches, with an operating valve for each, and perforated pipe extensions reaching between the tubes the entire width of the boiler. These extensions are so located and perforated as to direct steam jets at every part of the heating surface

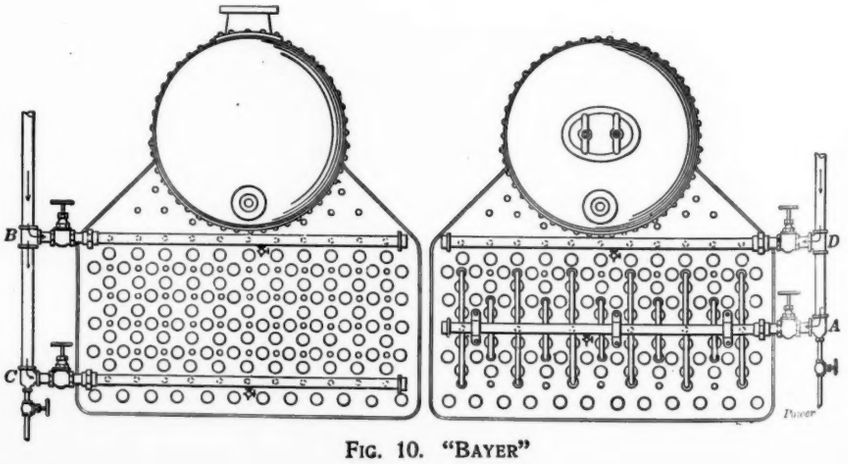


FIG. 10. "BAYER"

with effective force. Short three-way nozzles embedded in the brickwork complete the system, reaching the points of extreme temperature.

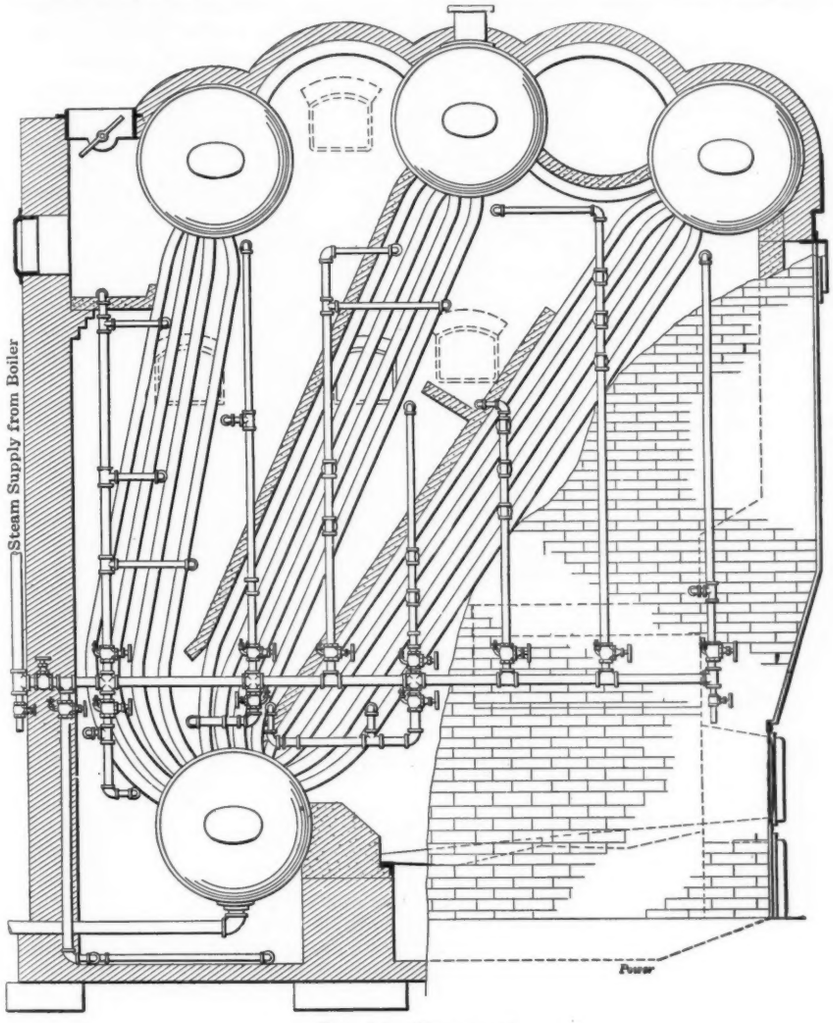


FIG. 11. "VULCAN"

The system is shown as applied to a Stirling boiler. It is operated by opening and closing the valves in succession and blowing with the draft, so that the operation interferes in no way with the regular working of the boiler.

The "Bayer" soot blower is a device for cleaning the tubes of water-tube boilers. In Fig. 10 is shown the elevation of the rear water leg of a water-tube boiler with the system in place. The lower header carries the nozzle for blowing the tubes between the upper and lower baffles. The upper header is used to agitate the dead spaces known to exist at the point where the jets come through the water legs. Fig. 13 shows a side elevation of the system as applied to a water-tube boiler.

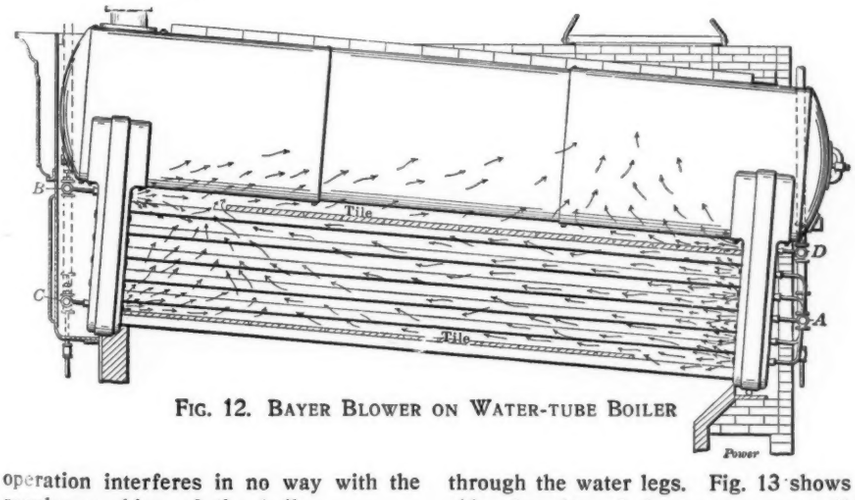


FIG. 12. BAYER BLOWER ON WATER-TUBE BOILER

When operating the system, it is necessary to open the controlling valves *A* and *B*, Fig. 12, about three minutes, letting them operate in conjunction. At the same time valves *C* and *D* are opened frequently during the operation in order to stir up the accumulations which have been blown into the space between the headers.

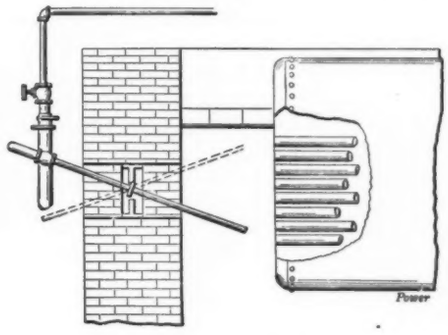


FIG. 13. "ARROW"

The system is easily installed. All that is necessary is to make a steam connection on the header or some other convenient source of steam supply and attach the blower by means of an ordinary union. The jet extends into the hollow stays flush with the inside of the water leg, and is thereby protected from the heat. This system is manufactured by the Bayer Soot Blower System.

The "Arrow" tube blower, shown in Fig. 13, is manufactured by the Arrow Specialty Company. It operates from the rear of the boiler, and the draft through the tubes assists the steam jet. The steam entering the tubes is sent through them at high velocity, much of the soot and fine ashes escaping up the chimney.

The steam pressure is not materially reduced as the blower tends to increase the draft, instead of retard it, so the rate of combustion and steam making is not interfered with.

The device consists of a single jet that can be used at any distance from the ends of the tubes, or it may be inserted into the tubes if desired. The motion of the jet is both horizontal and vertical, and the extreme positions are predetermined so that no steam can be wasted; all the steam issuing from the jet must enter the tubes.

[Since the foregoing article was written, descriptions of the improvements made in the design of both the Bayer and Monarch soot cleaner have been published in the December 6, 1910, number, pages 2169 and 2170.—EDITOR.]

Next fall, Pittsburg is to celebrate the centennial of steam navigation on the Ohio and Mississippi rivers. The "New Orleans" was the first steamboat to make the trip from Pittsburg to New Orleans, and it is claimed that the boilers were built by the great uncle of Col. T. R. Roosevelt.

Uncle Pegleg's Philosophy

The old man explains in a simple manner the operation of pulleys, or blocks as they are most always called, with one to a number of sheaves. He shows how a small pull can lift a big weight and brings out the difference the direction of pull makes.

"How much pull is there on the hook of that top pulley when they are hoisting a bag?"

They were putting a gravel roof on a neighboring mill and had a rig like Fig. 1 to hoist the bags of gravel.

"If the bag weighs 100 pounds and it's hanging on the pulley and the pulley is hanging on the hook, I suppose the pull on the hook is the weight of the bag and the pulley and the rope."

The old man simply looked at me in a manner which suggested that I keep on thinking.

"Plus the friction?" I suggested.

"We can forget the friction," he said.

"Plus the extra pull to get it started,"

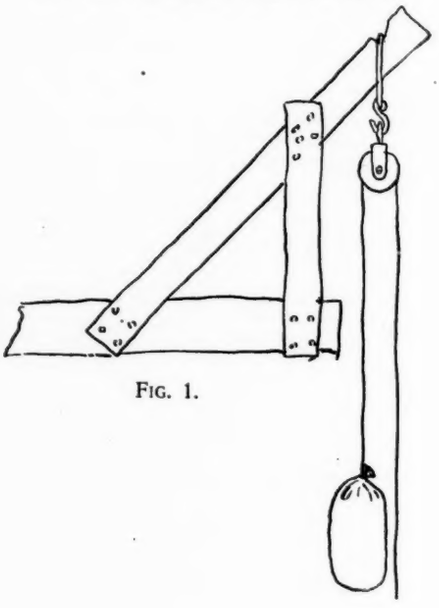


FIG. 1.

I guessed again, "like the big wrench on the elevator?"

"Well, that would come in," he said, "while the speed of the bag was being increased, but imagine it going up steady or standing still. You are thinking too far away and too complicated. Take the simple proportion and pick it apart."

I picked for some minutes but didn't get anywhere. Finaliy, the old man handed me a sketch like Fig. 2.

"How much pull is there on it now?" he asked.

"Two hundred pounds—for the gravel," I answered.

"Good, never mind the friction and the rest. Due to the gravel there's 200 pounds pull on the hook. Now, if I hold the rope as in Fig. 3 and let you take away the second bag of gravel, how hard have I got to pull to balance the original bag?"

"One hundred pounds."

"Well, how does the hook know whether it is the bag or I that's pulling on it? The two ropes are pulling down with a force of 100 pounds each, and it's just the same when the horse does the pulling; so you see a 100-pound bag of gravel can pull 200 pounds."

"No, the horse or the man pulls one hundred and the bag pulls the other hundred," I remonstrated.

FIG. 2.

FIG. 3.

He sketched Fig. 4 and said:

"Hang on the bag and you've got a pull of 200 pounds on the hook. Take off the bag and you've got no pull on the hook. How do you get away from it that a 100-pound bag pulls 200 pounds?"

"Ah, ha! I see," said I, "that's the way they gain power with a fall. The more ropes you use the more pull you get."

"No. The more ropes you put on the *less* pull you get, and you don't gain power at all."

"You don't gain power by using a fall?"

"Not a bit. To raise a 100-pound bag of gravel 55 feet in 10 seconds would take a horsepower whether you raised it with a four-rope fall or pulled it up with a dead pull."

"What is a fall good for then?" I asked.

"To let you do with a small force what it would otherwise take a big one to do. But force isn't power."

"What's the difference?"

"You know what force is, don't you?"

"Yes," I replied confidently.

"Well, what is it?"

After thinking it over, I concluded that I could exemplify better than I could define, and said, "When I push with my foot against the bench, that's a force."

"Yes, muscular force," approved the old man.

"And the bag of gravel pulls on the rope with a force?"

"The force of gravity; yes."

FIG. 4.

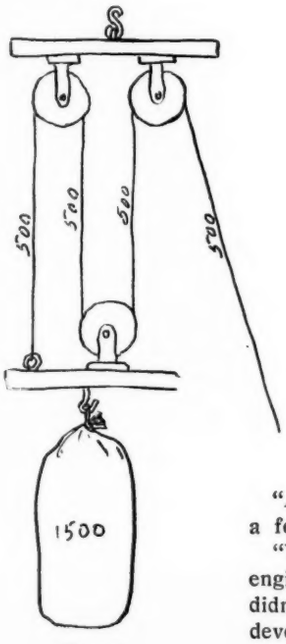


FIG. 5.

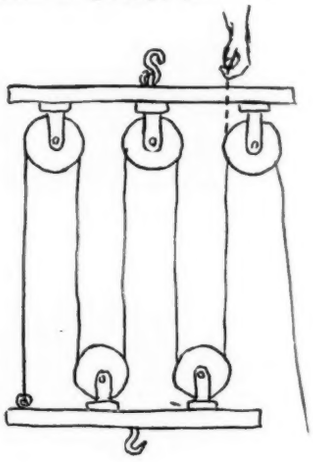


FIG. 6.

"And the steam pushes the piston with a force?"

"Yes," said the old man, "and, if the engine was on the center and the piston didn't move, there would be no energy developed and no power, would there?"

"No."

"You know what energy is?"

"Yes, force times space."

"Good. If the 100-pound bag of gravel is lifted 55 feet, how much energy will it take?"

"It will take

$$100 \times 55 = 5500 \textit{ foot-pounds,}"$$

I said.

"Correct. Now, you see, don't you, that it takes a more powerful machine

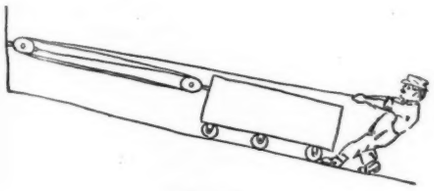


FIG. 7.

to lift that weight in a second than it does in a minute? To lift 10,000 pounds of water 100 feet will take 1,000,000 foot-pounds of *energy*, whether you lift it in a second or a year. A mighty small pump will put it up there if you give it time enough, but it takes a powerful pump to put it up quick, and the quicker the more powerful the pump. *Power* is *energy* divided by *time;* foot-pounds per minute or per second. A

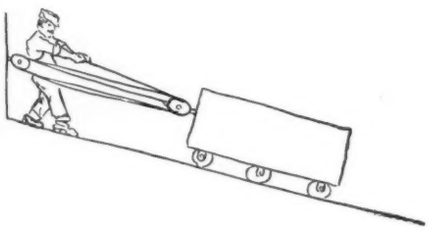


FIG. 8.

horsepower is 550 foot-pounds per second; so if the bag was lifted in 10 seconds the power would be

$$\frac{\text{force} \times \text{space}}{\text{time}} = \frac{100 \times 55}{10} = 550 \text{ ft. lbs. per sec.}$$

or one horsepower."

"I thought a horsepower was 33,000 foot-pounds," I said.

"So it is,

550 ft. lbs. per second
550 × 60 = 33 000 ft. lbs. per min.
33000 × 60 = 1,980,000 ft. lbs. per hour

"Now," Uncle Pegleg went on, "suppos'n that bag weighed 1500 pounds instead of 100, and the horse could not lift it. We could hang it like this," and he drew Fig. 5. "How many ropes is the bag hanging on?"

"Three," I answered.

"Then each rope has got to hold up only

$$1500 \div 3 = 500 \textit{ pounds,}$$

hasn't it?"

That was evident and I agreed to it.

"The pull on a free rope will run the same from end to end of it, won't it?" he pointed out. "You can't have 1000 pounds pull on one part of a rope and 500 on another without hitching it in between. Well, this rope is free from the end that is hitched to the lower block to the end that is hitched to the horse and the pull is the same in it all over. Then the pull in the part that runs to the horse is only 500 pounds and, if he can pull 500 pounds, he can lift the weight. By putting in more sheaves and ropes you can reduce the pull still more.

"In Fig. 6 you have five ropes, and the pull on each would be only

$$1500 \div 5 = 300 \textit{ pounds.}$$

The last pulley on top is only a leading pulley. You wouldn't have to pull any harder if you could throw it away and pull straight up as shown, but you'd have to stand up in the air to do it. Fellows who don't think, though, often use a tackle backward and pull against the load when they might as well be pulling with it."

I didn't look as though I understood, so Uncle Pegleg sketched Fig. 7.

"Here is a load that it takes, say, 900 pounds pull to drag up the incline. Supposing they are using a three-rope fall (Fig. 5), the man would have to pull 300 pounds to move the load, but if they went up beside the building, Fig. 8, and pulled, they would have to pull only

$$900 \div 4 = 225 \textit{ pounds,}$$

because all four ropes would be pulling on the load instead of four on the hitch and three on the load, as in Figs. 5 and 7. Use wit and save work."

"How are you going to save work?" I asked. "It takes so many foot-pounds to raise the load, don't it, whether you use your wits or not?"

"Yes," he answered. "You're right. You can't save work but you can save effort. You can pull 225 pounds instead of 300."

"I've only got to pull out so many feet of rope to pull the blocks together or to make the load come up so many feet, haven't I?"

"Sure," answered the old man.

"Well, if I pull out, say, 10 feet of rope with a pull of 225 pounds on it I do 2250 foot-pounds of work; and if I pull out 10 feet of rope with 300 pounds in it I do 3000 foot-pounds."

"Right," assented Uncle Pegleg.

"Then," said I, "it takes 2250 foot-pounds to lift the weight if you stand facing it and 3000 foot-pounds to lift it the same distance if you face the way its going?"

"No, it takes the same number of foot-pounds to lift it the same distance whichever way you pull or stand."

"Now, say," I remonstrated, "there's only so much rope on that fall, is there? I've only got to pull out so many feet of it to bring the blocks together, or to move the load up so much. If the pull is different and the number of feet of rope the same, then the work I do is different to lift the same load the same distance. How do you make it out?," I asked.

"You're wrong somewhere," said the old man, scratching his bald head. "It must be that the load doesn't come up so

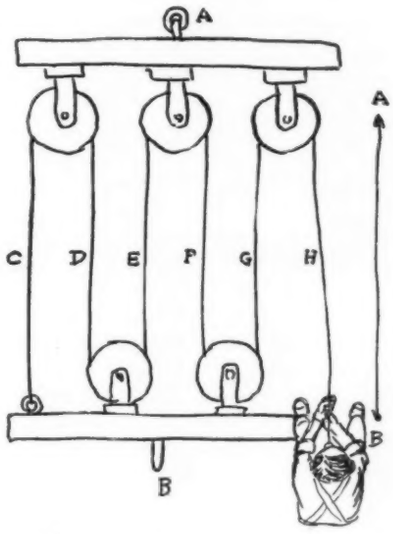


FIG. 9.

fast when you're pulling against it. Let's see," said he, sketching Fig. 9. "Suppose the man stands in the position shown and he pulls in 10 feet of rope. Now, if the anchor is at *A*, the distance *A B* from his hand to the leading pulley won't be shortened and the whole 10 feet will be taken up on the five strands *C, D, E, F* and *G*. They will be

$$10 \div 5 = 2 \textit{ feet}$$

shorter, so that a load hitched to *B* would move up 2 feet. If he had been pulling with a force of 100 pounds, he would have done

$$100 \times 10 = 1000 \textit{ foot-pounds}$$

and the load to oppose me would have been

$$1000 \div 2 = 500 \textit{ pounds.}$$

"Now suppose the anchor to have been at *B* and the load at *A*. The block with the three pulleys would have moved toward me. The distance *A B* would have been lessened. The 10 feet which he pulled would have been taken up by six ropes instead of five. Each rope would take up

$$10 \div 6 = 1\tfrac{2}{3} \textit{ feet}$$

instead of 2 feet, and the load attached to *A* would move up only $1\frac{2}{3}$ feet instead of 2 feet as it would if attached to *B*. If he still pulled 100 pounds and

did 1000 foot-pounds of work, it would handle a load of

$1000 \div 1\frac{2}{3} = 600$ pounds

instead of 500; and if there had been a load of only 500 pounds to handle, a pull of

$500 \times \frac{2}{3} - 10 = 83\frac{1}{3}$ lbs

would do it, because 500 pounds moved through 1⅔ feet is the work done on the load, and if the force that he uses is moved through 10 feet, it must be 83⅓ pounds to make the balance

$500 \times 1\frac{2}{3} = 833\frac{1}{3} \therefore 10 \times 83\frac{1}{3} = 833\frac{1}{3}$

I guess you'll find that these figures are in the same proportion as the others we had. What were they?"

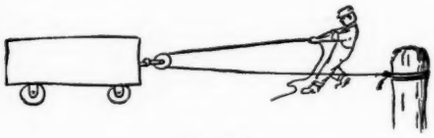


FIG. 10.

"It took 300 pounds one way and 225 pounds the other."

"Well," said he, setting the figures on his slide rule and poking it at me, "you see that

$\frac{225}{300} = \frac{3}{4}$

but

$\frac{83\frac{1}{3}}{100} = \frac{5}{6}$

We were dealing with a three-rope tackle in the first case and a five-rope in the second. The more ropes you use the less you gain proportionally by making one of them work instead of lead. I could have shown you better with a single pulley. In the first case (Figs. 1, 2, 3, 4), the pull on the hoisting rope has got to be equal to the load, because the pulley only leads and the load travels as fast as the rope does, but in this case, Fig. 10, the load only comes ahead 1 foot for every 2 feet of rope that the man pulls in so that his pull has got to be only one-half as much."

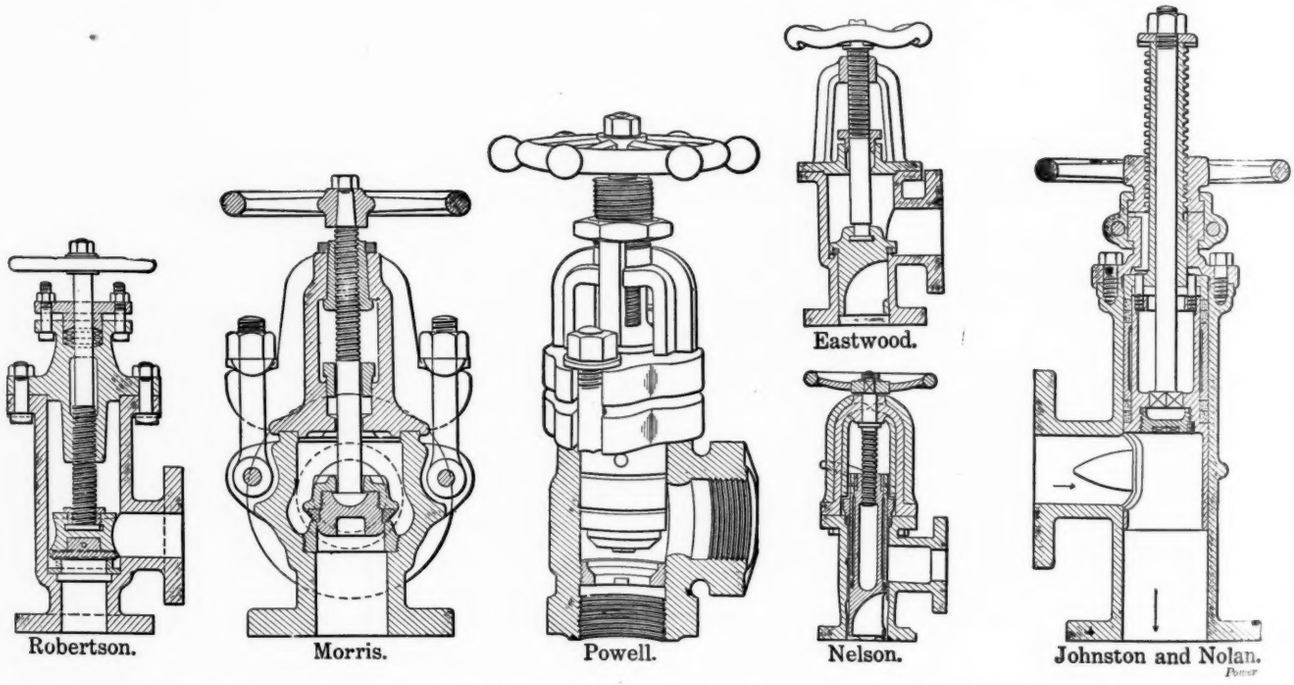
Blowoff Valves of the Angle Type

By Charles J. Simeon

A concise de ription of the various types of blowoff valve of the convenient angle type, giving prominence to the features of construction and manipulation.

The angle type of blowoff valve was naturally developed largely because of the fact that, having to be placed below the boiler, an angle valve is frequently the most convenient form to use. The shape, however, has advantages that should not be overlooked, among which are ease of applying the principle of seat-washing, arranging for the joint surfaces of both valve and seat to be exposed as little as possible to the cutting action of the flow, and giving easy access for regrinding or renewal without disturbing the body. The feature of self-cleaning, as its name suggests, consists of means provided to insure that the seat will be automatically freed from foreign matter during the act of closing. It is an improvement that has been applied during the development. This end is usually attained by placing the seat ring in a deep recess in the body so that the main flow of water is nearly cut off in the act of closing, while the surface of the movable disk is still some distance from the seat. This leaves a narrow annular opening which is too small for the passage of large pieces of scale, but is still large enough to allow a stream of water to pass and wash away any sediment that comes to rest on the seat before the disk actually touches it. This feature is made a special point of in the Golden, Cadman, Lunkenheimer, Faber, Erwood, Pittsburg Foundry and Valve Company, Pittsburg Valve and Fittings Company, Kelley & Jones and Best. In all except the Faber the washing is accomplished in the same way; the water that flows past the seat is utilized to clean it.

Several are alike in having seats and disks that are easily renewed. The disk in most cases consists of a heavy piston-shaped plug into which is dovetailed, or which carries, a renewable ring. The



ping is made a snug fit in the cylindrical chamber of the body and deep enough to overlap the inlet opening when closed. This design, besides causing the valve to be guided to its seat, insures that any large piece of scale that may have stuck across the opening will be sheared off without damaging the working faces, and that no scale can prevent the movement of the valve by lodging between it and the bonnet.

In the Cadman the valve ring is of soft copper with a hard-brass collar shrunk over it to prevent spreading. The seat ring is clamped between the lower and central castings of the body.

The Lunkenheimer, like the Cadman, has a reversible ring and a poke hole, ordinarily stopped by a threaded plug, opposite the inlet. through which sediment may be removed without dismantling while not under pressure.

In the Faber the general principle is the same but the actual cleaning is done by an auxiliary jet of clean water, steam or compressed air caused to play over the seat through a narrow annular opening just before the seat faces come together.

In the Erwood the seat washing has been reduced to the utmost simplicity. The body has an internal thread in which runs a solid plug the lower face of which has an annular groove filled with lead that makes a joint with a deeply recessed seat.

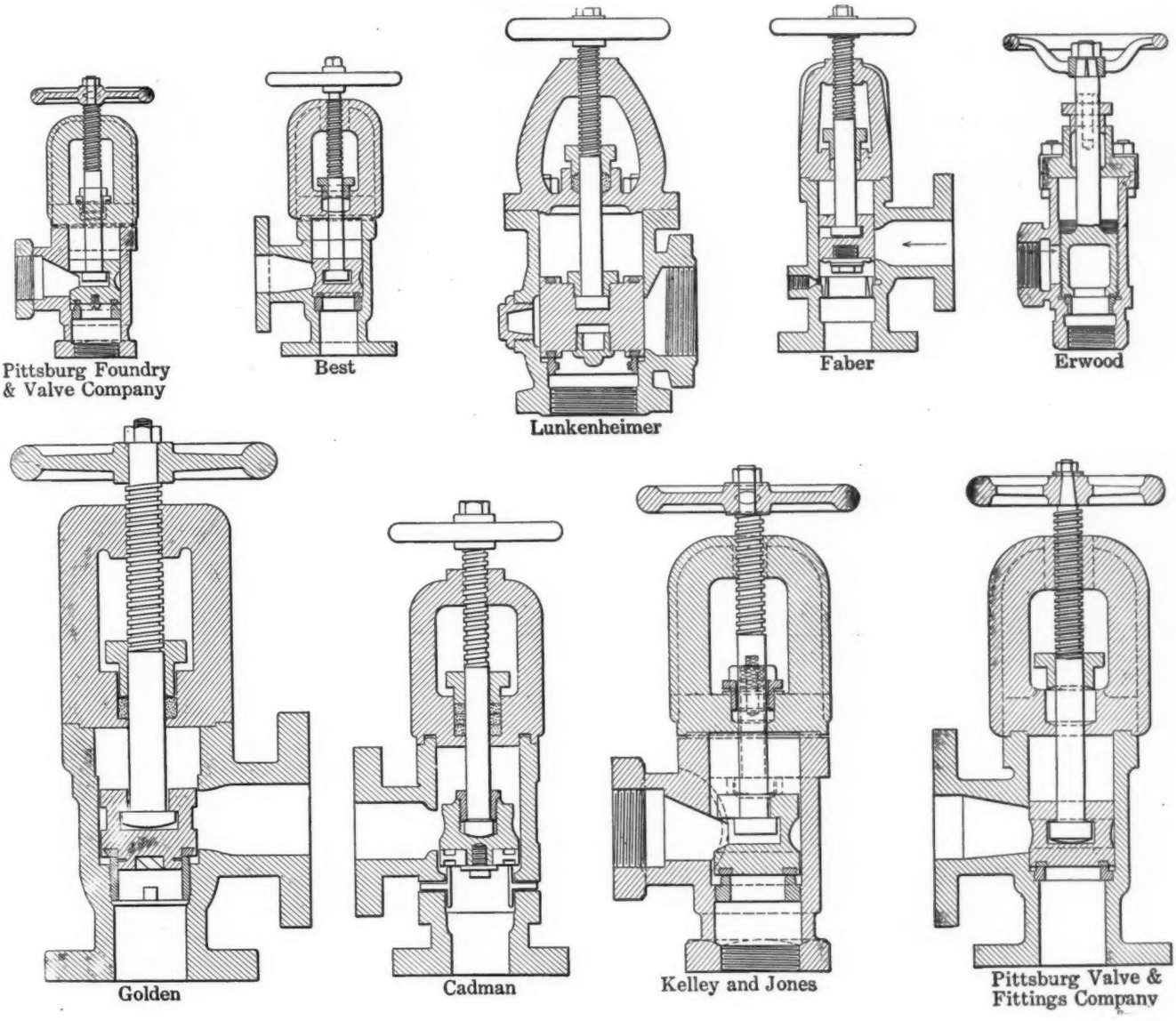
The Powell is similar in general construction to the others. The disk is renewable and reversible, and the seat ring has internal lugs to facilitate removal. There is no provision for seat washing, but the probability of the lodgment of scale on the seat is reduced by cutting it at a steep angle.

The designers of the Morris have worked on the assumption that a blow-off, from the nature of its use, is subjected to such severe treatment that serious wear of disk and seat cannot be avoided; and have turned their efforts toward making a valve that may be very easily dismantled for renewal. The body and cap are heavy castings with tongued and grooved joints held together by swivel eyebolts that hinge in the body. The disk has a renewable soft-metal ring and the seat ring is easily removable for refacing.

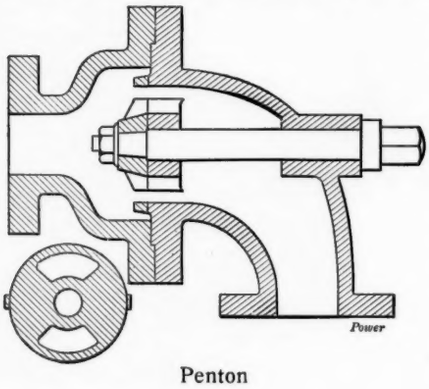
The Johnston & Nolan has a long hollow piston fitted with rings top and bottom. The body is a bored tube with the inlet about the middle of its length. In the closed position the rings make a tight joint above and below the inlet. In the open position both sets of rings are out of the flow, and an extension of the piston protects the surface of the tube. The rings may be expanded while under pressure by means of a nut at the top of the stem.

The Eastwood and the Nelson are similar in that each has a clear opening and that provision is made for protecting the seating surfaces. The Eastwood, however, is a disk valve with a projection which guides the flow past the seat.

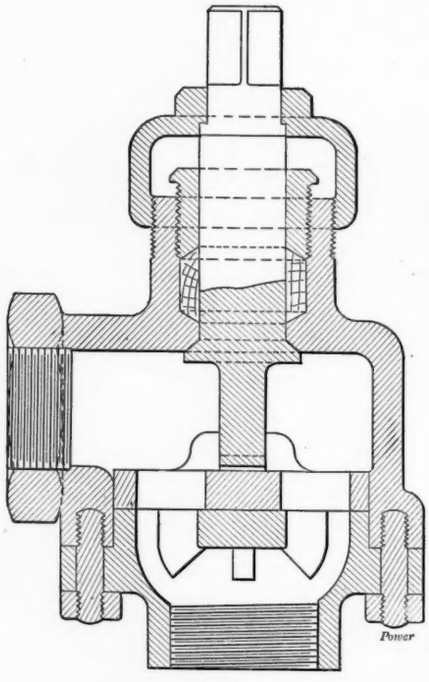
In the Nelson the inlet and outlet are controlled by the reciprocating piston



which in the open position provides a curved port. The piston has a V-shaped recess directly over the curved port to retain the packing, and is adjusted by the gland sleeve, which is also provided with similar V-shaped recess. The gland sleeve is carried by the piston and adjusted by an octagonal nut which is screwed onto the upper end of the piston and is rotated by the double-handled wrench. This wrench cannot be removed from the valve without disassembling, but may be lifted so as to re-engage the octagonal nut in any position.



Penton



Riggin

The gland sleeve has a flattened portion to engage a similar flattened portion below the thread on the end of the piston, and engages with the guide ribs on the yoke which prevent the rotation of the piston so that the curved port of the piston will register with the inlet connection when in an open position.

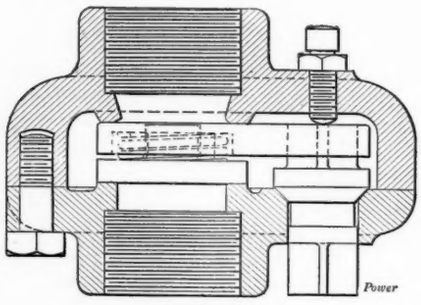
The travel of the piston is limited in its open position by a collar, and in its closed position by the lugs at the outlet connection.

The Penton and the Riggin have sector-shaped passages in the disk which register with similarly shaped openings in the seat when the stem is rotated to the open position. These valves, designed on the principle of the slide valve, are not unlike, except in outward appearance, to the Everlasting and the R. C., in which a port in the seat is opened and closed by a sliding disk operated by a lever on the outside of the case and requiring but a slight movement for the full range of travel of the disk.

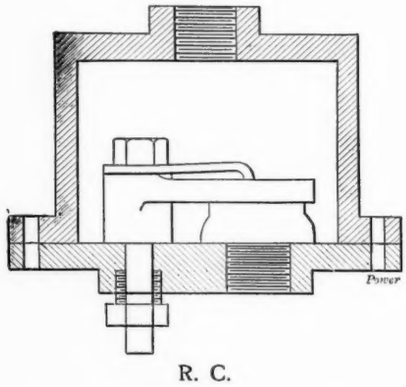
There is also another type in which the passage is opened and closed by a sliding disk or cover or by a rotating cap. In these the cover is held to its seat and the joint made tight by the pressure of the water.

In the Rothchild there is a hollow perforated plug rising in the center of the case, covered by a closely fitting split cap which is rotated by a forked stem connected to lugs on the outside of the cap. Through a small pipe rising through the stem of the rotating fork the oil reservoir in the top of the central plug may be replenished.

In a class by itself is the Eclipse, in which the inner end of the stem is expanded to a sort of mushroom head which must be moved against the pressure in opening. It is so constructed that it may be ground while under pressure.



Everlasting

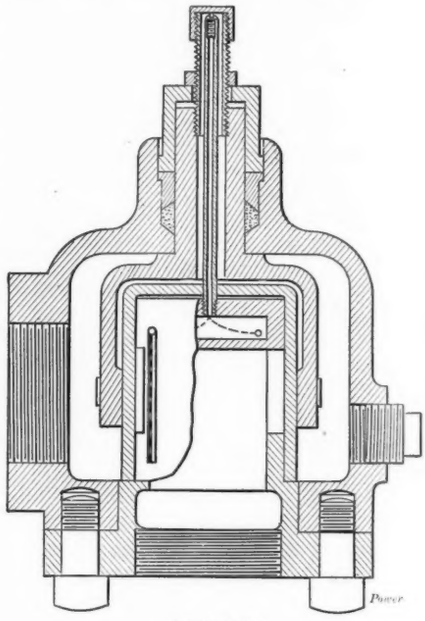


R. C.

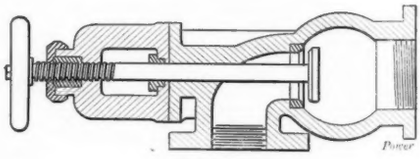
Nearly all the metals have been used in the manufacture of blowoff valves and cocks. The body castings are of brass or cast iron in small sizes, and cast iron, malleable iron or steel in the larger ones.

In many types the seat ring is a separate piece, screwed into the body and capable of renewal or repair. Owing to the greater difficulty of removing or re-grinding this part, as compared with the disk, the ring is often made of a very hard material that will withstand the cutting influences to which it is subjected. The metal usually chosen is bronze, though hard brass is also used.

Much greater variety is seen among the materials chosen for the disks. In some instances a hard metal, such as bronze or iron, is used. In such cases provision is usually made for grinding the two together in place. In the majority, however, a soft material is used. This may be soft copper, rubber composition,



Rothchild



Eclipse

or hard metal with rings of lead or babbitt metal cast into annular dovetailed grooves. Whichever form is chosen the intention is to give a surface that will adapt itself to any irregularities in the surface of the harder seat ring, and to cause as much of the wear as possible to take place on the easily removable disk instead of the seat, which must of necessity be a tight fit in the body. Such disks have the advantage of being very cheaply replaced.

With so many manufacturers, who are specialists on valves and all problems and conditions pertaining to their use, offering such widely different patterns it would be presumptuous to venture an opinion as to whether this or that particular valve is the best. Conditions of service and the user's judgment must determine the choice. It must not be forgotten that a valve is not gifted with sense or volition, and that none invented is fool proof. Much depends on the operator and the care which he uses.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Lightning Investigations

Ever since the experiments made by Franklin with his kite and key, investigators have endeavored to measure the amount of energy stored in a flash of lightning. For a long time about all that was known was that a lightning flash represents a transfer of energy from cloud to cloud or from cloud to earth, the transfer of energy taking place by means of a current of electricity. Later, by means of viewing the lightning flash in a revolving set of mirrors, and, still later by photographing a lightning flash on the film of a moving-picture camera, it was found that the stroke instead of being a discharge with a steady flow is pulsating in character, the frequency being usually very high. Faraday's discovery of the principle of induction furnished an explanation for the damage done to persons and property near the objects struck.

Last spring the Engineering Experiment Station of the University of Illinois began an investigation on the subject of protection against lightning. On a large open field on the university farm were erected twelve 40-foot telephone poles. Of these six were equipped with special devices for indicating the effect of lightning strokes at or near this system of poles. It is hoped by means of these instruments to gain some further insight into the laws underlying the phenomena of lightning. During the past summer there have been very few storms accompanied by lightning, and no strokes have hit any of the poles, yet indications have been given of the effect of strokes, at a distance. It is planned to add special recording devices to the present equipment and to continue the tests.

The equipment when complete will consist of a series of spark gaps shunted by resistance, inductance and capacity in series. The lightning may jump across the gaps or pass round them through the shunt circuits. Any action due to lightning will be recorded on a moving strip of paper driven by clockwork, so that the exact time of the electrical disturbance can be told from the record of the apparatus. From a knowledge of the length of the spark gaps and the record of which gaps are jumped by the lightning it is hoped that various characteristics of the stroke may be determined.

Three of the poles have been equipped with sharp needle points, and three with 6-inch brass balls. The first points were of steel and rusted badly. Silver-plated points were substituted, but they rusted nearly as quickly as the first set. On inspection all the points were found to be bent over as if softened by heat. The points were all bent so that they pointed to the northeast. Several theories have been advanced to explain this curious phenomenon. The work is being carried on by T. D. Yensen, of the Engineering Experiment Station corps.

Electrical Restrictions in Cleveland

The city of Cleveland on November 21 adopted an electrical code placing all electrical construction, interior wiring street lines for signal, fire alarm, power and other purposes under the control of the building department. This division of the department will be in charge of an electrical engineer with the title of city electrician, at a salary of $2000 per annum, and will comprise a chief inspector of electricity at $1500 per annum; a permit clerk at $1000, and six inspectors of electrical wiring and appliances. All of these officials are to be placed under bonds.

All wires except the trolley lines and arc-lamp poles are to be removed from a number of streets in the central portion of the city before June 1, 1911, and on another list of streets, further out, the removal and placing underground of lines must be commenced on January 1, 1911.

Largest Electric Motor in the World

The 6500-horsepower motor for driving the 60-inch universal mill at Gary, described in this department some months ago, was considered the largest motor in the world. A report comes from England, however, of a motor being built by the Siemens Brothers Dynamo Works, Stafford, which completely overshadows the Gary unit. The British motor is designed for direct current and is intended to develop 10,000 horsepower at 60 revolutions per minute with current at 920 volts. It is so designed that it can be operated at 1400 volts, which will be done later, when it will carry peak loads of 15,000 brake horsepower at 90 revolutions per minute. It will be coupled direct to a 36-inch cogging mill and a finishing mill, and will roll 2½-ton ingots down to rails in one operation without reheating. It is stated that the operator will be able to reverse the motor from full speed in one direction to full speed in the other nearly 30 times per minute.—*Compressed Air Magazine.*

Automatic Generator-Motor

At the Laconia mills, Biddeford, Me., the superintendent, W. S. Mitchell, is using a 200-kilowatt three-phase alternator as a link between a limited water power and a larger generating plant to transfer power from the one to the other, in either direction, according to existing conditions. The alternator is belted to a pulley on the main shaft of a weaving mill which is driven by water power, and it is connected in parallel with the generators driven by other prime movers and with the large turbine-driven generator of the neighboring Pepperill mills. When there is ample water power, the generator at the weaving mill delivers power into the general system, but when the water is low or fails, the generator operates as a motor, taking power from the general system and either assisting its water wheel or driving the weaving mill entirely, according to the condition of the water supply.

LETTERS

Mr. Greer's Puzzling Converter Trouble

The phenomena cited in C. L. Greer's article published in the November 15 issue were due to the facts that the three converters are operated on the alternating-current side from a common set of busbars instead of from separate transformers for each rotary, as is the more common practice, and that the direct-current negative terminals of the three machines are tied together through the negative switches and circuit-breakers. With all positive switches open there is then a complete electric circuit between No. 1 and No. 3 as follows: from the negative brush of No. 3 machine, through the negative lead to the negative busbar, thence by way of the negative lead of No. 1 machine to the negative brush, through the armature to the collector rings, from the collector rings through the alternating-current leads to the alternating-current busbars, thence through

the leads of No. 3 machine and through the armature winding to the negative brush of No. 3, completing the circuit. This same kind of circuit exists also between Nos. 1 and 2 converters.

A potential tending to cause a flow of current in these closed circuits may exist due to inequalities in the brush setting, the size of reactive coils and field strength of No. 1 and Nos. 2 and 3, and of a value depending on how closely these adjustments correspond. Therefore, with Nos. 2 and 3 running on the west feeder a local flow of current through these closed circuits between No. 1 and Nos. 2 and 3 might take place when the negative switch and circuit-breaker of No. 1 were closed. Should no disturbance occur when the negative switch and circuit-breaker of No. 1 were closed it might develop when the connection *J* was closed, due to the increase in the field strength of No. 1 converter caused by the flow of the load current of the east feeder through the series field winding of No. 1. No trouble would be expected between Nos. 2 and 3, because these machines were being operated directly in parallel and their voltages would therefore be carefully adjusted. No. 1, being considered as operating independently of Nos. 2 and 3, probably did not have its voltage closely adjusted to equal that of Nos. 2 and 3.

As the three converters equalize on the positive side, the ammeters would, of course, be in the negative lead and would show the current exchanged between No. 1 and the other converters. Had these machines been equalized on the negative side, with the ammeters in the positive leads, the ammeters would have given no indication of trouble and would have shown only the current taken by the feeders.

The phenomena cited by Mr. Greer would not have occurred had each converter been operated from a separate bank of transformers.

L. McKENNEY.

Wappinger's Falls, N. Y.

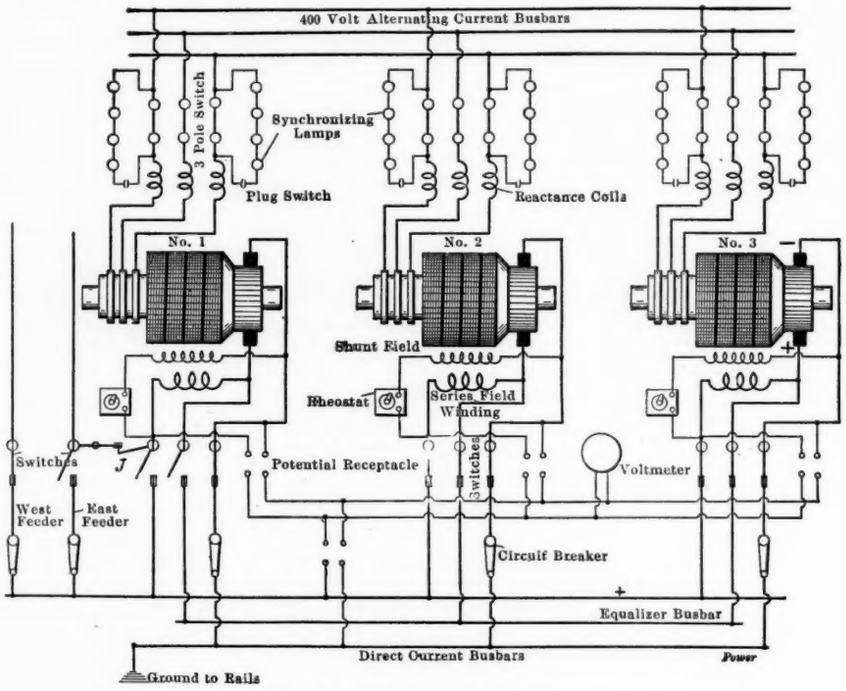
The armature of a rotary has only one winding, which is connected both to the commutator and to the collector rings; consequently, there is a continuous metallic circuit between the collector rings and the commutator. Now, keeping this fact in mind and remembering that the three converters are connected in parallel at the alternating-current terminals, without the intervention of transformers, and that all three machines were connected to the grounded side of the railway circuit, what Mr. Greer described as happening would be just what I should expect to happen.

Nos. 2 and 3 converters were tied together with No. 1 at the positive direct-current brushes just as truly as if the positive switch had been closed, the tying together being accomplished through the armature connections to the alternating-current terminals, and it is evident that all necessary conditions for parallel operation existed except that the equalizer switch on No. 1 converter was open. Had this switch been closed it is likely that No. 1 machine would not have "hogged" the load to as great an extent as it did, but, of course, the machines would not have operated satisfactorily because, as Mr. Greer states, they would not do so even with the positive switch closed.

The result which Mr. Greer observed would not have occurred, of course, with direct-current generators or motor-generators, nor would it have occurred had separate transformers for each rotary converter been inserted between the alternating-current busbars and the converters.

F. M. FARWELL.

Duquesne, Penn.



CONNECTIONS OF MR. GREER'S ROTARY CONVERTERS

As Nos. 2 and 3 are connected directly in parallel they may be considered as one machine so far as No. 1 is concerned, or one of them can be ignored. In the accompanying diagram I have done this and have also omitted the alternating-current connections because they have nothing to do with my explanation.

Since all of the machines are connected to the track or grounded side of the railway circuit, and all of the feeders are connected to the trolley wire, which I assume to be continuous, the machines are connected in parallel even though the regular positive switch of No. 1 is open. The main connections, stripped of the "side issues" and unimportant details, are as shown in the accompanying diagram, so that the converters are paralleled on the direct-current side through the moderate resistance of the feeders and trolley wire. When No. 1 was connected to the east feeder, its voltage was evidently higher than that of the other converters and it forced current backward through them by way of the trolley wire and feeders. The series field windings made matters worse because the equalizer switch of No. 1 was open.

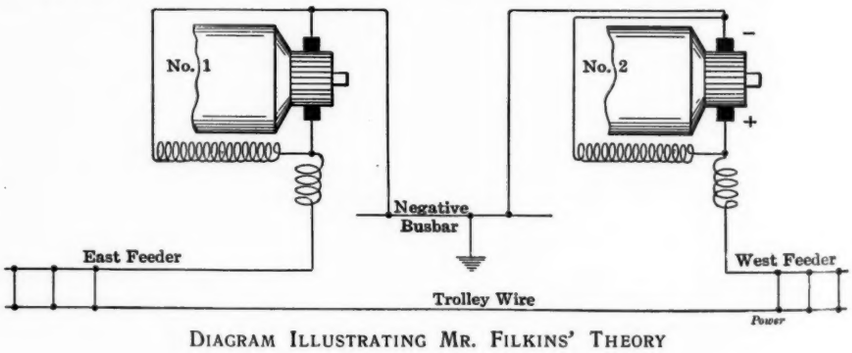


DIAGRAM ILLUSTRATING MR. FILKINS' THEORY

EARL R. FILKINS.

Milwaukee, Wis.

Gas Power Department

Modifications of the Humphrey Pump*

By Herbert A. Humphrey

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

Two-stroke Cycle Pump

One other important modification of the single-barrel pump depends for its successful operation upon the fact that the burnt gases are so well cooled at the end of the long expansion stroke that they will not ignite an incoming combustible charge. It therefore becomes possible to have a true two-stroke-cycle pump. The action will be understood by reference to Fig. 10, which shows only the top of the combustion chamber. The combustion chamber has to be specially shaped so that the incoming charge, which may be preceded by pure air, displaces the burnt products and mixes as little as possible with them. Thus, in the figure, the admission valve *A* is located at the top of a tall but narrow part of the chamber *B*, in which the full-charge volume extends down to the level *c c*. A number of exhaust valves *E* lead to a common exhaust outlet *O*, which may be fitted with a nonreturn valve, or each exhaust valve may carry a light nonreturn valve on its spindle as shown. The level at which expansion reaches atmospheric pressures is, say, *f f*, but this level having been reached by the water, its further movement draws in fresh combustible mixture till it occupies the space down to *c c*, and the liquid level has fallen to *g g*. The column of liquid then returns and drives the exhaust products through the valves *E* (which opened by their own weight) until these valves are shut by the water. The kinetic energy acquired by the column is then spent in compressing the fresh charge, which is ignited to start a new cycle. Thus each outstroke is a working stroke, and no locking gear is required on the valves. A higher compression pressure is obtained with this arrangement than with the simple pump, and consequently higher efficiencies with the same lift.

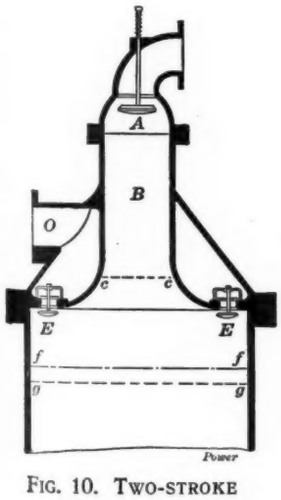


Fig. 10. Two-stroke Cycle Pump

The Two-cylinder Pump

Fig. 11 illustrates the elemental parts and arrangement of the double-barrel pump, corresponding to a two-cylinder engine. There are two combustion chambers *A* and *B*, in which explosions occur alternately. In each barrel the usual cycle of compression, explosion, expansion, exhaust and the taking in of the new charge, is carried out, with the four strokes of unequal length. In this case, as in that of Fig. 10, the water column has only one outward and one inward movement per cycle, but the expression "two-stroke" would here be misleading, unless applied only to the water column, and not to what occurs in the combustion chambers.

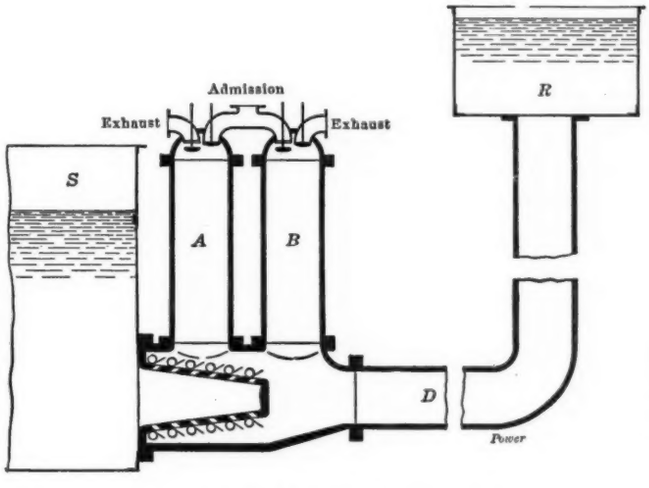


Fig. 11. Two-cylinder Pump

For example, assume that a compressed combustible charge exists in the top of chamber *A*, and that *B* is full of water. Explosion and expansion in *A* cause the outward propulsion of the water column, and when atmospheric pressure is reached the exhaust valve of *A* opens, water flows in to follow the column and to rise in *A*, expelling burnt products; there being insufficient pressure to maintain the water in *B*, the level therein falls, causing an intake into *B* of a fresh combustible charge. All this takes place during the outward movement of the column of water, and then the column coming to rest commences to return toward the chambers. The remaining burnt products in *A* are sent out through the still open exhaust valve by the returning water, whereas the new charge in *B* cannot escape because the admission valve is now shut, under the action of its spring. Consequently the column rises at first in *A* until the exhaust valve is shut, and then in *B*, compressing the new charge. Ignition in *B* starts a fresh cycle with the functions of *A* and *B* exchanged.

There are important differences between the action of this pump and of the single-barrel pump first described. The new charge is taken in merely by water falling under the action of gravity, and does not depend upon the compression and expansion of an elastic cushion. The clearance spaces at the tops of the combustion chambers may therefore be reduced to the very small volume needed to bring easily to rest that portion only of the column which rises in the chamber, the main body of the column being brought to rest by the compression of the new charge. Again, for a given delivery head, the compression pressure at-

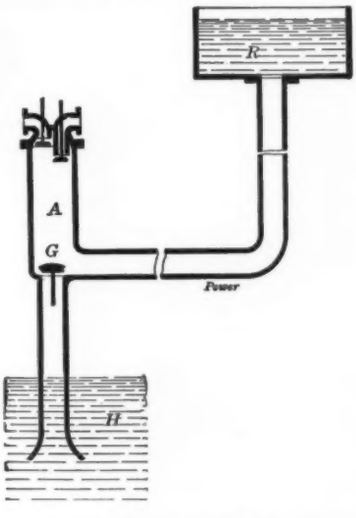


Fig. 12. Suction-lift Pump

*Second part of abstract from a paper read before the Manchester Association of Engineers. First part appeared in the December 13 number.

tained is higher in the double-barrel pump, because the returning column gains speed while exhausting the last part of the burnt products, and thereby obtains a store of kinetic energy before starting the compression stroke proper.

The advantages of the two-barrel over the simplest of the single-barrel pumps, briefly stated, are higher explosion pressure for the same water lift, due to reduced clearance resulting in less contamination of the new charge by residual burnt products, and to higher compression pressure; more cycles in unit time, and greater output for a given total weight of pump and play pipe.

Suction-lift and High-pressure Pumps

So far we have considered only those pumps which have a submerged suction and a limited delivery head of 40 feet. We will now take a brief glance at a few of the types capable of working with a suction lift, and others for delivery against high heads.

Fig. 12 is a diagram of one kind of suction-lift pump, the cycle of which is as follows:

1. Explosion of compressed combustible charge in *A* driving water to the high-level tank *K;* continuation of expansion stroke below atmosphere owing to the existence of nonreturn valve in exhaust pipe. Consequent lowering of pressure till water is raised from the supply tank *H,* past the valve *G,* until the water comes to rest and the valve *G* shuts.

2. Return movement of the water column toward the chamber *A,* giving exhaust and cushion stroke.

3. Cushion expansion, and inlet of a measured combustible charge into *A,* and expansion of this charge below atmosphere.

4. Second return of the water column toward *A,* giving the compression stroke.

The measured charge involved in step 3 of the cycle may be obtained in many ways, one of the simplest being by the use of gas bags, the diaphragms of which are attached to valves, and on being drawn in actuate the valves to close the outlet. The use of a measuring device can, however, be obviated by employing the "rejected charge" device to be described in connection with air compressors.

A two-barrel suction pump is illustrated by diagram in Fig. 13. The combustion chambers *A* and *B* are connected to the play pipe *D,* but the water-suction pipe is at the opposite end of the play pipe, and in addition there is an air chamber *C,* with check valves *N* and *M.* The cycle will be readily surmised. On explosion in *A* the water column moves outwardly from the chambers and compresses the air in *C* until the pressure is sufficient to lift the valve *N* and pass water into the high-level tank. On the column coming to rest the valve *N* shuts and the compressed air in *C* expands again, imparting velocity to the column which carries the expansion below atmosphere; this lifts water from the low-level tank at the same time that exhaust from *A* and compression of the new charge in *B* take place. The cycle is then repeated.

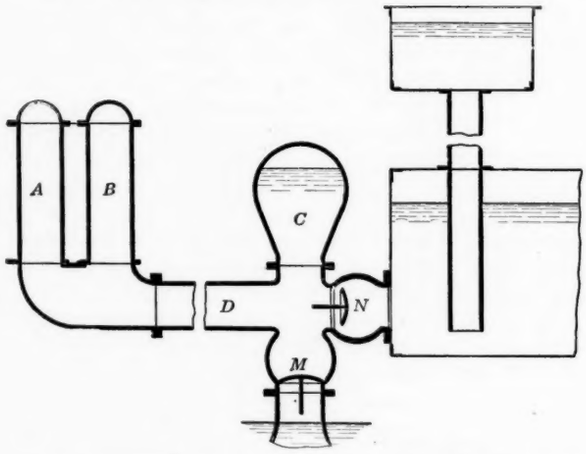


Fig. 13. Suction Lift and High-pressure Delivery

Any Humphrey pump, whether single or double barrel, may be converted into a high-pressure pump by means of an air vessel fitted with valves and called an "intensifier." The idea is to first allow the water column to gain velocity and then to utilize its kinetic energy to compress an elastic fluid and deliver water under the pressure to which the elastic fluid has been compressed. In Fig. 14 *A* and *B* are the barrels of a two-barrel pump, and at the end of the play pipe *D* there are two air vessels *E* and *F,* the latter being large enough to give a continuous flow at the outlet *O,* and to maintain a practically uniform pressure. The smaller air vessel *E* is fitted with a downwardly projecting pipe *K,* open to the atmosphere at the top and carrying a valve *L* at its lower extremity arranged to close under the action of the rising water. The cycle starts with explosion, all valves except *L* being shut and the water level as shown. While the water level in *E* is rising, air is merely discharged into the atmosphere, and as no work is being done by the column of water it gains velocity until the valve *L* is shut by impact. Imprisoned in *E* there is now a definite quantity of air which suffers compression until its pressure reaches that at which the high-pressure water valves *W* can open and allow the remaining kinetic energy of the column to force water into *F.* The valves *W* close when the column comes to rest, but there remains enough energy in the compressed air in *E* to give, by expansion, the return flow, which causes exhaust in *A* and compression of the fresh charge in *B* to start a fresh cycle. When the water level falls below the valve *L* it opens and air is admitted into *E* for the rest of the return stroke.

It is easy to see that if the pipe *K* is made vertically adjustable with regard to *E,* the point of the cycle at which *L* shuts can be varied, and more or less air can be entrapped in *E.* But the amount of energy stored in this air will also vary with its quantity, for we assume that the degree of compression remains constant, and is indeed fixed by the pressure maintained in *F.* Consequently the ratio of the total energy of the working stroke to the energy stored in the compressed air in *E* can be made anything desired; in other words, any compression pressure of the new charge in *B* can be obtained, independent of the water lift. The advantage is obvious, for compression pressures equal to those in modern gas engines can be employed with a corresponding increase in thermal efficiency. Further, by manipulating the position of the pipe *K* a given pump can be made to meet any conditions as to hight of delivery, for if the head increases, *K* can be raised so that the energy stored in the air in *E* remains the same, there being now less air but at a higher pressure.

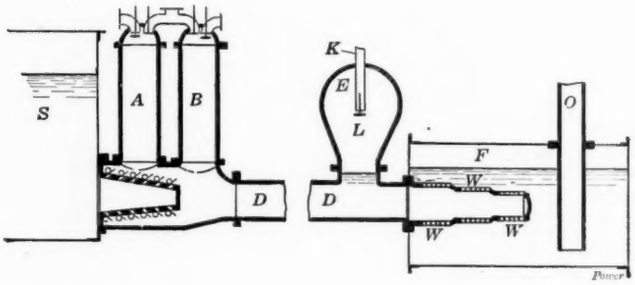


Fig. 14. Two-cyclinder Pump for High Delivery Head

An important development of the arrangement shown in Fig. 14 is of practical interest. Remember that at each cycle air is drawn into and rejected from the vessel *E;* then suppose *K* is connected to a supply of combustible mixture instead of opening into the atmosphere. This makes an automatic auxiliary pump for taking in mixture and discharging it under pressure, and if the discharge is into a

reservoir from which the combustion chambers *A* and *B* can be supplied, we have a means of quickening the cycles and greatly increasing the output of a given size of apparatus. It is convenient to replace the vessel *E* by two vessels, one for air and one for gas, so as to maintain the combustible constituents separate until they enter the combustion chambers. If the first portion of the outstroke of the water column is allowed to reject the surplus air and gas back to the sources of supply, then the action throughout the cycle is precisely that described when using the single vessel *E*, except that a larger proportion of the total energy is absorbed in the compression of air and gas but the excess is given out again during the expansion of the precompressed charge in either *A* or *B*.

The chief advantage of the form just described lies in the more rapid working; there is no need to wait for the water level in *A* or *B* to fall under the action of gravity when the charge is being taken in. In fact, the apparatus becomes practically independent of the water level on the supply side. A 1000-horsepower Humphrey pump now under construction in Germany will operate in the manner just described, the result being that the dimensions are very moderate, and the pump itself occupies no more space than a 1000-horsepower tandem gas engine.

Notes on a Large Gas Producer*

By Nisbet Latta

Generally speaking, heavy-duty gas engines have been confined to operations where either natural gas or blast-furnace gas was available; hence, before they can be generally adopted some method for the economical manufacture of a satisfactory gas in large volumes must be assured. The difficulties of such manufacture have been many, and a few of them are herewith cited.

The initial introduction of gas producers into the United States was unfortunate and the failure of the greater number of the first installations cast upon the producer a cloud of discredit which has never been removed entirely from the public mind. This failure was due, in most part, to the wrong hypothesis that because this apparatus had been successful in England and on the Continent it must necessarily be so in this country. The fallacy of this idea was due to the single variable, the nature of the fuel used. The easily fusible ash contained in the English and German coals permitted a high rate of combustion, averaging 18 to 20 pounds per square foot of cross-section. When operation at this rate was attempted here, it was found to be impossible to control the fire bed, the resulting temperature being such as to flux and finally fuse the ash and to produce other conditions inconsistent with satisfactory operation.

To avoid this condition of affairs, the rating of American producers has steadily been decreased until the best practice now averages from 8 to 9 pounds of fuel gasified per square foot of grate surface. This change has rectified to a great extent the difficulties met with in the introduction of the apparatus upon this side of the Atlantic. Producer-gas plants, however, are relatively small in size, while the heavy-duty gas engine for power purposes is essentially an apparatus of large capacity and demand. The average gas producer in common practice today does not exceed 500 horsepower in size. Even at this size, and invariably beyond it, mechanical troubles occur which are difficult if not impossible to remedy. For instance, in producers of great diameter there are different heat zones or strata, due to the difference of temperature between the center of the apparatus and the sides, which are cooled to some extent by radiation. Moreover, large diameters cause almost insurmountable difficulties in stoking and prevent the possibility of maintaining the fuel bed at a high efficiency.

Again, the labor of cleaning is immeasurably increased. This condition of affairs is peculiarly emphasized in the case of caking or coking coals containing a high percentage of fines (coal under ¼-inch mesh) which tend to form a homogeneous mass, packing or caking the bed. The limit of fines in the case of pressure producers seems to be about 15 per cent. for caking coal and about 40 per cent. for free-burning coal. With the latter 65 per cent. of fines is the maximum obtained in commercial operation. In some coals the ash fuses at an

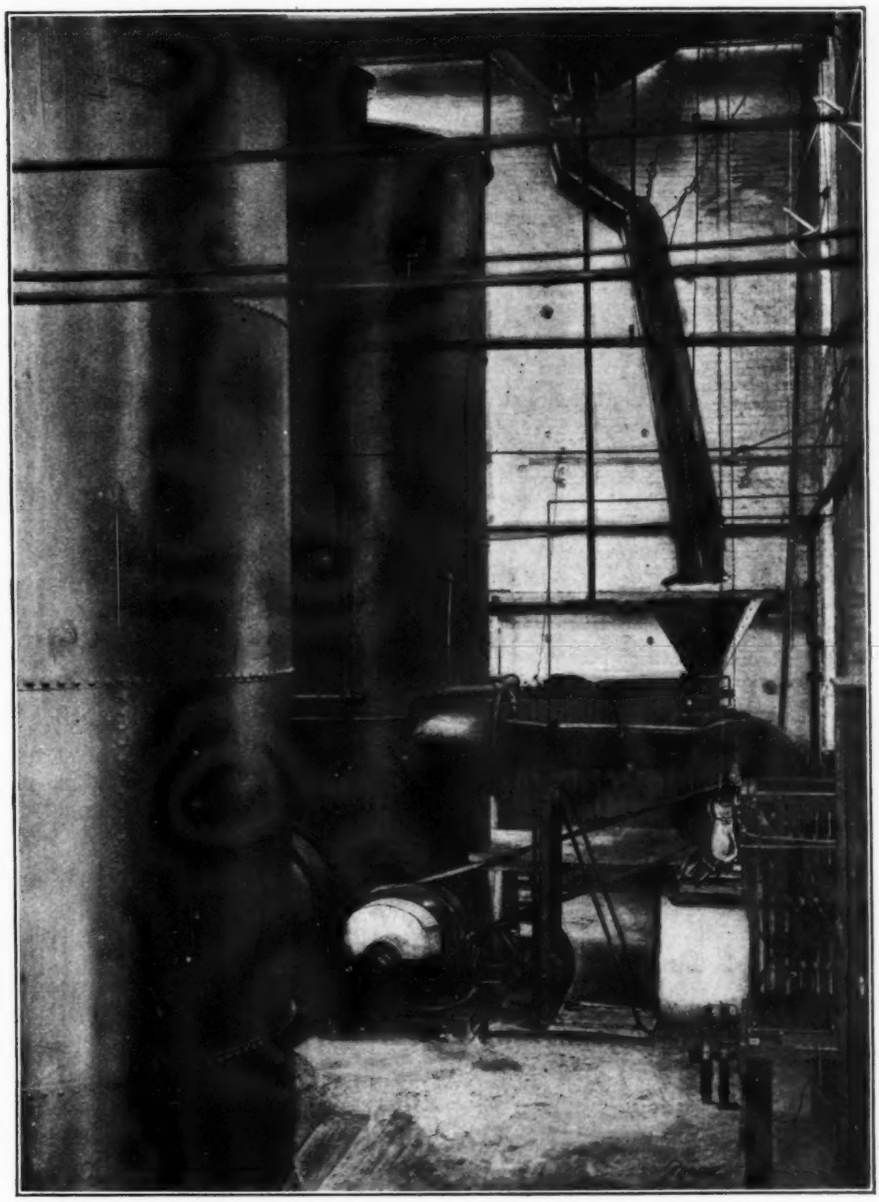


Fig. 1. Part of Hirt Apparatus, Showing Pulverizer at the Right

*Abstract of a paper read before the American Society of Mechanical Engineers, December, 1910.

early stage of combustion, while others form a densely packed or "mucky" bed, almost like molten asphalt.

The difficulty of operation under these conditions has hitherto been met by some expedient such as mechanical agitation; agitation by a reverse blast of compressed gas through the generator is also used. The backward blast lifts the bed and redisposes it, blows out the ashes from the interstices of the fuel and makes the fuel surface more active. This method, especially in a producer of moderate size, can unquestionably be commended.

Nevertheless, the fact remains that, although the medium-sized producer, of, say, 750 horsepower, has been developed with a reasonable degree of success, there is as yet no gas-producing apparatus which may be said to be a consort for the heavy-duty steel-plant type of gas engine of 3000 to 5000 horsepower.

It has been claimed that the solution of the matter consists in the use of a number of producer units connected in

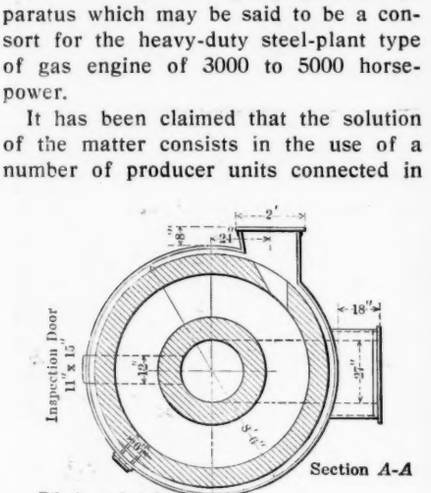


FIG. 2. HORIZONTAL AND VERTICAL SECTIONS OF GENERATOR

batteries or multiples, analogy being made with steam-boiler practice. This analogy fails by reason of the essential difference in the character of the service. For instance, within certain limits the question of boiler operation means merely the delivery of steam at a certain pressure, the pressure regulation between the boilers being a matter which is comparatively simple. The efficient operation of a gas engine, however, necessitates the delivery not only of a continuous supply of gas, but of gas of uniform composition. This condition is made even more complex by a variable load, and the process of operating in harmony a multiplicity of producer units is more difficult in practice than it would seem theoretically.

The foregoing facts explain the reason for starting, about a year ago, a series of experiments on a large mechanically operated producer. Although incomplete as yet, they tend to show the possibilities of the manufacture of gas on a large scale at a low cost.

The apparatus selected was of the pulverized-fuel type, the one herein described having originally been designed by L. H. Hirt. This type of producer is hardly an innovation, having been used in France by Georges Marconnet, a French engineer, to supply gas fuel to engines for the generation of power and to open-hearth furnaces.

The Hirt apparatus consists of a pulverizer, a retort or generator and a tower scrubber or other gas-cleaning device. Fig. 1 shows the pulverizer and part of the generator and scrubber. Fig. 3 is a nearer view of the pulverizer. The fuel is first broken to a reasonable uniform size, of say ¾ inch, by passage through a crusher or griffin mill, from which it usually passes through a storage hopper to the pulverizer. Here it is ground to a satisfactory degree of fineness in the presence of air. Not only is a high degree of intimacy on the part of the elements secured, but by this arrangement coal containing a maximum of 12 per cent. to 15 per cent. of moisture may be ground without predrying. The mixture lacking sufficient air to permit complete combustion, is then admitted tangentially into the producer or retort through opening *B*, Fig. 2. After combustion, the gas takes an upward course through the gasifying chamber and passes down the central passage, escaping at the bottom to the scrubber.

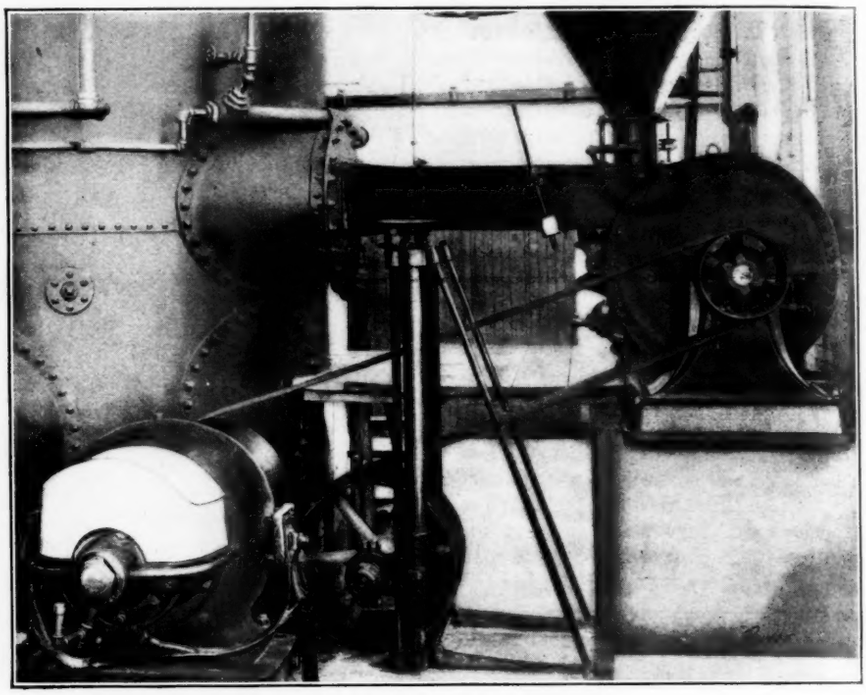


FIG. 3. CLOSE VIEW OF PULVERIZER

Heretofore the difficulties experienced in operation with pulverized fuel have been largely the high temperature of combustion and the impossibility of maintaining a refractory material against such intense temperature. In the operation of

TABLE 1. ANALYSES OF PRODUCER GAS.

VOLUMETRIC PERCENTAGES.

Carbon monoxide.	23.7	27.5	26.5	27.0	24.5	15.85	13.52	12.20	18.2	13.8	* 18.9
Carbon dioxide...	3.9	2.8	2.9	5.0	3.9	9.20	8.10	7.60	4.9	8.0	9.4
Hydrogen.....	10.0	11.5	11.0	9.5	9.8	6.17	11.51	10.50	12.2	10.4	12.2
Methane.....	.....	.....	.....	.....	3.4	4.09	5.17	3.20	2.1	2.5	.....
Oxygen.....	.....	.....	.....	.....	.....	1.40	0.30	0	0.1	0	.....
Nitrogen.....	.....	.....	.....	.....	.....	63.29	61.40	66.50	62.4	64.8	.....
Illuminants.....	.....	.....	.....	.....	.....	.....	.....	.....	0.1	0.5	.....
B.t.u. per cu.ft., total.....	.....	.....	.....	.....	.....	.....	.....	.....	128.89	119.70	.....

*Steam admitted to upper chamber.

this producer, however, the combustion is incomplete. In starting up the producer it is necessary to permit complete combustion for a sufficient period to raise the linings to the temperature of gasification, this temperature being subsequently maintained by the reaction of gasification in the natural process of manufacture within the apparatus. According to Alexander M. Gow,* 4450 B.t.u. are liberated when a pound of carbon is burned to CO; as the weight of the entire products of combustion of one pound of carbon burned to CO is 6.76 pounds, on the basis of their average specific heat, the theoretical temperature attained would be practically 2240 degrees Fahrenheit. The oxidation of carbon begins at the low temperature of 400 degrees Centigrade (752 degrees Fahrenheit), the reaction being complete at 995 degrees Centigrade (1823 degrees Fahrenheit). These facts merely serve to indicate that the heat supplied by the exothermic reaction

$$2\ C + O_2 = 2\ CO$$

would be sufficient for the operation of the producer.

Perhaps the only serious difficulty met with in the continuous and uniform operation of the apparatus was caused by the construction of the producer upon the hypothesis of the inventor that all coals could be carried up to a temperature at which the ash would fuse, so that it could be removed in the form of slag. This was an error which soon developed. It has been demonstrated that only fuels containing easily fusible ash can be handled in such a manner, and that these fuels are the exception rather than the rule. The apparatus having been constructed upon this premise, the removal of ash was a clumsy and inconvenient performance. It was necessary to accumulate an ash bed sufficiently deep to seal the producer and then gradually and carefully withdraw it from the bottom. This difficulty, however, would be easily remedied in a producer designed with the knowledge of the foregoing experiments. Either a water-sealed bottom or a conical dumping bottom would be entirely practical.

In the experiments herein cited the pulverizer was driven by an electric motor. In commercial operation, however, the sensible heat of the effluent gases would be more than sufficient to generate steam to drive all auxiliary apparatus. The interposition of a waste-heat boiler between the producer and the scrubber, such as is used in the Loomis-Pettibone apparatus or in connection with water-gas sets, would unquestionably give satisfactory results.

TABLE 2. PROXIMATE ANALYSES OF COAL.

PERCENTAGES BY WEIGHT.

		*	
Moisture	0.52	1.20	0.73
Volatile matter	17.50	32.95	17.52
Fixed carbon	72.48	59.64	76.80
Ash	9.50	6.21	4.95
Sulphur	1.24	.....	.....
B.t.u. (dried coal)	.....	13,925	14,550

*Analysis of ash from this coal: silica, 43.62; aluminum and iron oxide, 42; lime, 5.74; magnesia, 2.22.

Bituminous coals of a wide range were used and the operation of the producer with fuels containing up to 30 per cent. of ash and 15 per cent. of moisture was demonstrated. Some typical analyses of the gases, as made by the Pittsburg Testing Laboratories, are given in Table 1.

There is, however, a definite ratio between the fuel used, the degree of fineness to which it is ground and the time the gas remains within the producer. That is, adjustment should be made to suit the chemical analysis and the physical nature of the fuel. The length of the downcomer should depend upon both of these elements, the length varying, in all probability, inversely as the percentage of volatile matter contained in the coal.

Transactions, Engineers' Society of Western Pennsylvania, May, 1903, p. 14.

A New High Speed Diesel Engine

BY S. SNUYFF

There was exhibited at the Brussels exposition a 600-horsepower Diesel engine, built by the Holland Engineering Works, Amsterdam, which embodies two important and several minor departures from previous practice in the construction of this type of oil engine. The chief differences are in the use of a crosshead and guide similar to those of a steam engine, and a short, hollow water-cooled piston, which is, of course, closed all round. The piston is secured to a flange on the piston-rod end with studs and is provided with twelve packing rings to keep in the high pressures of compression and combustion. The interior of the piston is kept in communication with the circulating-water supply and discharge by means of two little brass pipes, which are fastened to the under side of the piston and slide up and down in two stationary brass barrels mounted on the engine frame. The barrel through which the water is delivered to the piston is provided with a stuffing box, because this water is under slight pressure, but the delivery barrel is not packed.

The cooling of the piston has been adopted because of the large diameter of the piston and the high speed. There are several reasons why the designers have found it desirable to adopt the cross head and guides, but the principal objects were to avoid lateral pressure between the piston and cylinder walls and to make the wristpin end of the connecting rod fully accessible and free from the influence of the heat in the cylinder.

The crosshead has one block or slipper running between guides on both sides, and the connecting-rod end is forked, straddling the crosshead block. It is rather interesting to note that the first Diesel engines, designed by Herr Diesel several years ago, were built with crossheads and guides.

The valve motion too is of improved design. Instead of using cams to actuate the short rocking levers which open the inlet and exhaust valves, eccentrics are used. This was found advisable with the new high-speed engine in large powers in order to obtain silent operation. The engine compares favorably with the steam engine as regards quiet, steady running with varying loads. The cyclic irregularity is $\frac{1}{200}$.

The engine at the exposition was direct connected to a direct-current generator of 350 kilowatts output supplying electrical energy for power and lighting purposes to the Holland section of the International Machinery Hall. There are four cylinders $19\frac{11}{16}$ inches in diameter; the stroke is $25\frac{5}{8}$ inches and the speed 210 revolutions per minute. The piston speed, therefore, is 900 feet a minute.

The guaranteed fuel rate of the new engine, using oil of 18,000 B.t.u. per pound, is 0.37 pound per brake horsepower-hour at full load, 0.429 at three-quarters load, 0.495 at one-half load and 0.771 at one-quarter load. The corresponding thermal efficiencies are 38.2 per cent., 33, 28.6 and 18.3 per cent.

They hev a little Irish feller ilin' over t' th' power house by th' name uv Jimmy Maloney. Th' brush holders uv wun uv th' dinymos got t' runnin' hot tother day an' th' super'ntendent sed th' "pig tails" wuz busted an' they'd hev t' git sum new wuns. He told Jimmy t' chase hisself down t' th' shop an' see ef he cud scare up 'bout haf a dozen. Jimmy wuz gone 'bout two hours an' kum back puffin' like a foundered steer. He hed th' pig tails all rite, an' they wuz th' real thing. Sed he'd went t' every dumd butsher shop in th' town an' cudn't find any an' hed t' go out in th' kentry t' a farmer's pasture t' git 'em. Sed he hed a heluva time ketchin' sum uv th' pigs but he'd maniged t' round up six uv 'em an' sep'rate 'em frum their tails arter he'd purty dumd night killed hisself runnin' the pesky critters down.

Readers with Something to Say

Home Study

Now that the long winter evenings are with us, the engineer should settle down to hard work and set aside a certain number of hours each day for study.

Successful home study requires that the reading be done in a systematic manner and that the student select the branches of engineering in which he particularly needs instruction, and then exhaust the subject from every point of view. He may decide on a purely theoretical course, including physics, chemistry, the elements of steam and electrical engineering, or he may select a mathematical course, analyzing and applying the formula of engineering, from the coal pile to the apparatus where the energy is finally utilized.

While employed in a plant containing quite a variety of machinery, I went through such a course, and so impressed the formulas and constants on my mind that it is only necessary to recall the particular piece of apparatus to remember the method of making various calculations.

If a practical course is decided on, it should start at the boiler room and systematically take all apparatus in order, dealing with design, construction, operation and repair and the description of all prominent makes of machinery and the work for which each is best suited. It may be desirable to take some one subject such as "boilers" and study it from a practical, mathematical and theoretical point. In preparing such a course, a complete outline should be made forming a synopsis from which to study. It can be made up by dividing and subdividing the subject down to the smallest detail, using the index of textbooks and engineering magazines to select the items. The outline can best be kept in a notebook, using a line for each item and skipping every other line for filling in items found later.

Starting with such a guide, take each item and look it up in all available literature, making a note of the article or articles which best cover the subject. It is well to read all the descriptions of central stations and isolated plants possible and note the types and capacity of the apparatus selected. Catalogs of manufactures should be obtained and the design of the apparatus studied. Such a course carefully carried out should enable anyone with an ordinary education to become master of any such subject if he employs his time industriously and with intelligence.

LEWIS C. REYNOLDS.

Willard, N. Y.

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Safety of Dished and Flanged Heads

Owing to the failure of a number of dished and flanged heads during the last ten or fifteen years, an unwarranted prejudice has sprung up against this form of head. I can advisedly say prejudice, for, as a matter of fact, there is nothing wrong with this type of head when properly made. I believe that it can be demonstrated that the whole trouble is in the flanging and comes from an effort on the part of the workmen to make the head enter the shell easily when assembling. To do this, too much taper is given the flanged portion of the head, and when riveted in place this produces a strain tending to straighten back the flange, as shown in Figs. 1 and 2, and it is liable to start a fracture as at *A*, Fig. 2. This fracture may not show up for some time, but the constant flexure, caused by the variation in pressure, will gradually cause crystallization. Another cause of fracture is flanging the head too far over and then knocking it back, and especially this is generally done in hand flanging and when the material is not sufficiently heated.

There is only one way to avoid this trouble and that is to flange the head to a good-sized radius and just far enough to make the flanged part parallel with the shell, as shown in Fig. 3. To do this, I prefer turning the flange on a flanging machine that is designed to roll the flange. Some engineers specify angle braces or through rods, but either one is objectionable and absolutely unnecessary if the head is thick enough and properly flanged. Double riveting is also sometimes specified when it is not required and only adds expense.

The radius of flange knuckles is usually made less than that shown, in which case the liability of fracture is greater when the heads are not properly flanged.

JOHN J. HOPPES.

Springfield, O.

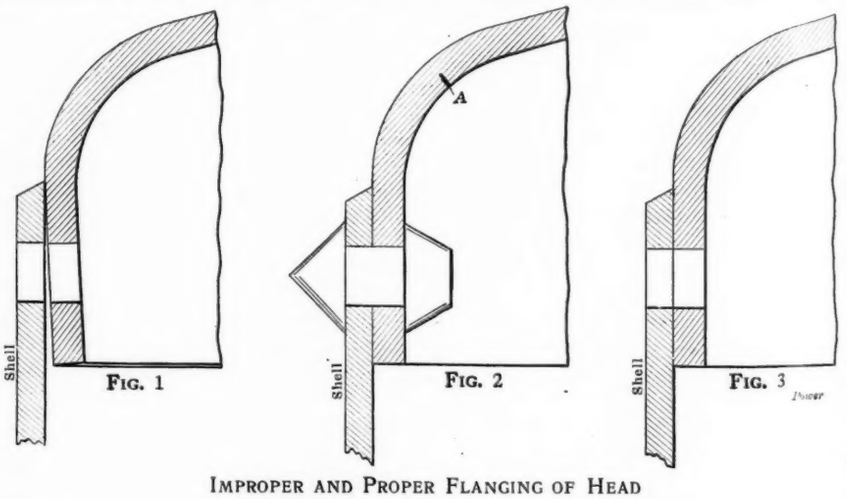


FIG. 1 FIG. 2 FIG. 3

IMPROPER AND PROPER FLANGING OF HEAD

Hydrostatic Boiler Test

Some time ago I saw a boiler tested that had been allowed to freeze up during a cold snap. The engineer had no force pump or apparatus of any kind, yet he tested the boiler to the desired pressure, 100 pounds.

The boiler was filled with water, leaving no air space whatever, and then a small fire was built under the boiler, and as the cold water warmed up and expanded, the pressure gradually increased until the gage registered the desired testing pressure.

Then the try cocks were opened, allowing a small quantity of water to escape and relieve the pressure. Having found the boiler in good condition, the water was drained from the boiler to a proper level and the engineer then proceeded to get up steam.

H. D. CHAPMAN.

Washington, D. C.

[While the foregoing method of conducting a hydrostatic test may be used as stated, extreme care should be taken

not to build too hot a fire, and above all to keep a careful watch on the gage so that an excessive pressure will not be put on the boiler.—EDITOR.]

How to Make a Flash Boiler and Magneto

I would like to ask if any reader can give me the necessary directions for making a flash boiler for a 3x4½-inch engine to be run at a speed of 200 revolutions per minute.

I would also like directions for making a magneto for gas-engine ignition.

C. E. ANDERSON.

Minneapolis, Minn.

Correcting a Packing Trouble

Packing waste is often due to too much open space around the piston rod in the gland and cylinder head. When this condition exists, fibrous packing will invariably disintegrate and be drawn into these spaces to be blown out onto the crosshead and guide or into the cylinder, eventually finding its way through the exhaust passages to the heater and sometimes causing trouble by clogging the exhaust drains. Prolific waste from this cause has undoubtedly gone on for years in some plants, the real cause remaining unknown, while many different kinds of expensive packing have been experimented with to no avail.

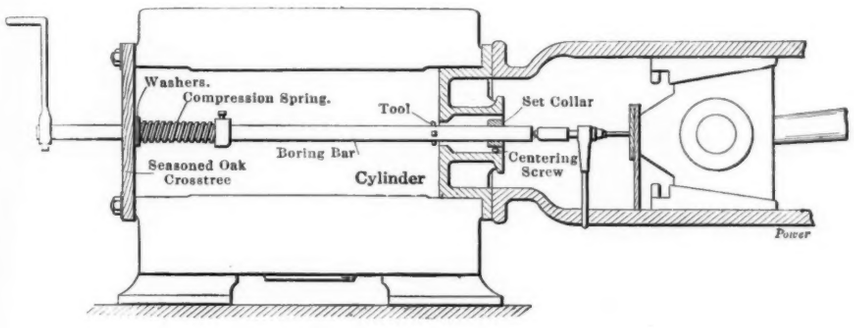


FIG. 1. BORING TOOL IN PLACE

A certain Corliss engine having a 4¼-inch piston rod had been mishandled for a long time, no care having been taken to set the piston central with the cylinder, with the result that the holes in the head and gland were worn so badly that there was nearly ⅛-inch space all around the rod. When freshly packed, this stuffing box would sometimes begin to blow within two days, and by the end of a week would need several new rings of packing. This condition was partly overcome by using a very hard packing ring at each end and soft packing in the middle until an opportunity came to make permanent repairs.

A piece of shafting, drilled and tapped for a tool and setscrew, as shown in Fig. 1, was utilized for a boring bar, and a set collar for centering the boring bar in the stuffing box was drilled for three setscrews. Another set collar, a stiff steel compression spring and two large washers completed the boring bar. A seasoned oak strap was bolted across the center of the cylinder and bored to receive the boring bar at the head end. The boring bar was then centered to the counterbore at both ends of the cylinder by means of pointed pine-wood trams about ⅜ inch in diameter and having a pin driven into each end for lengthwise adjustment. The boring bar was then pushed forward so that the disengaged tool was at the extreme end of its outward travel. The crosshead was moved up to a convenient position and a ratchet drill inserted between it and the boring bar. The set collar and spring were then shoved up to the washers against the oak crosstree, as shown; grease was placed between the two washers and the setscrew tightened. The ratchet feed was then unscrewed until the tool was at the beginning of its travel and the tool was set for the first cut.

The hole was trued and enlarged to the required size and countersunk at the cylinder end and a brass thimble, shown at *A*, Fig. 2, was riveted into place.

The stuffing box has given no further trouble and has now been running for months without the addition of new packing.

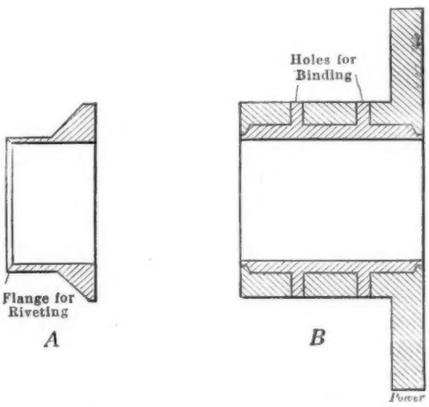


FIG. 2. BRASS THIMBLE AND BABBITT-LINED GLAND

The gland was sent to the shop with the intention of having a brass bushing inserted but no suitable casting for the purpose was at hand; and, as it would have required some time to secure one, it was decided to bush the gland with babbitt. This was done as shown at *B*, Fig. 2. This has run successfully for an entire season, and in one instance, where an unskilled attendant tightened the gland to a cramped position, no harm was done to the rod, whereas if a harder metal lining had been used the rod would have been heated and perhaps scored.

F. C. HOLLY.

Yazoo City, Miss.

Automatic Nonreturn Valves

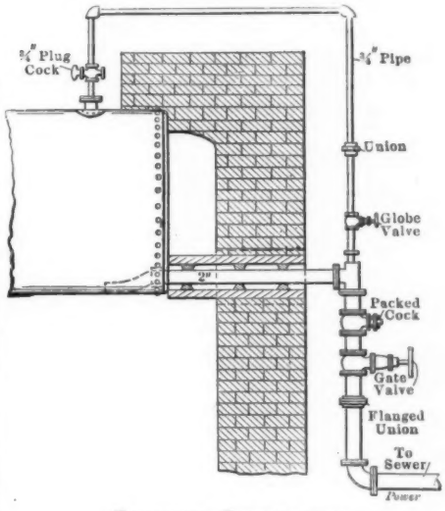
I would like to hear from engineers as to their experience with automatic nonreturn valves. Are they as successful as manufacturers claim them to be, and will they chatter and hammer so as to become useless? Will the engine or the vibration of the header cause the valve to hammer, and, if so, is there any way of stopping the trouble?

LOUIS J. CORILLA.

Ironwood, Mich.

Position of Blowoff Pipe

The accompanying sketch shows the way in which the blowoff is connected to my boiler, a method which has given no trouble for the past ten years, except for renewing the disks on the valves about once a year. The pipe enters the boiler through the back head with a long thread to which, inside the boiler, is connected an offset pipe and coupling. The pipe is protected by a cast-iron sleeve one inch thick, having lugs cast inside to center the pipe and provide an air space around it. The opening through the brickwork is considerably larger than the sleeve and the intervening space is packed with loose asbestos. Outside the brickwork the pipe is connected to a reducing tee the small



BLOWOFF CONNECTION

end of which is connected to the steam dome of the boiler; this keeps up the circulation in the pipe. The lower end is fitted with a packed cock and a gate valve and leads to the sewer.

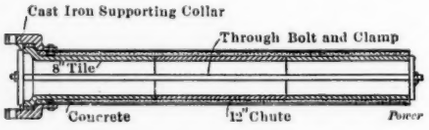
EDWARD HAMILTON.

Ridgefield Park, N. J.

Lining Coal Chutes with Tile

At the plant in which I am employed we had a number of 12-inch coal chutes which had been patched with sheet metal until there was hardly enough left of some to hold them together. We then decided to line our chutes with virtified tile, as shown in the accompanying sketch, and have found them to be almost everlasting.

The tile is assembled and clamped with the bolt, then wrapped with expanded



COAL CHUTE LINED WITH TILE

metal for the whole length. The tile is then inserted in the chute, and is centered and concreted while held in a vertical position. After the concrete has set the bolts and clamps are removed.

Where the chutes have been badly eaten away ½-inch iron rods may be used to reinforce the tile, and the outside may be given a good appearance by grouting over with cement. If the tile lining were used on new chutes, only a light steel shell would be necessary; hence the first cost would not be increased very much. For hard coal an 8-inch inside diameter is sufficient for most any requirements.

H. B. SCHAMBERG.

Scranton, Penn.

A Homemade Friction Drive

The accompanying illustration shows a double-friction drive which I have tried and found fairly successful. The driven shafting runs in synchronism with the engine shafting two-thirds of the time, and there is an emergency clutch for quick action.

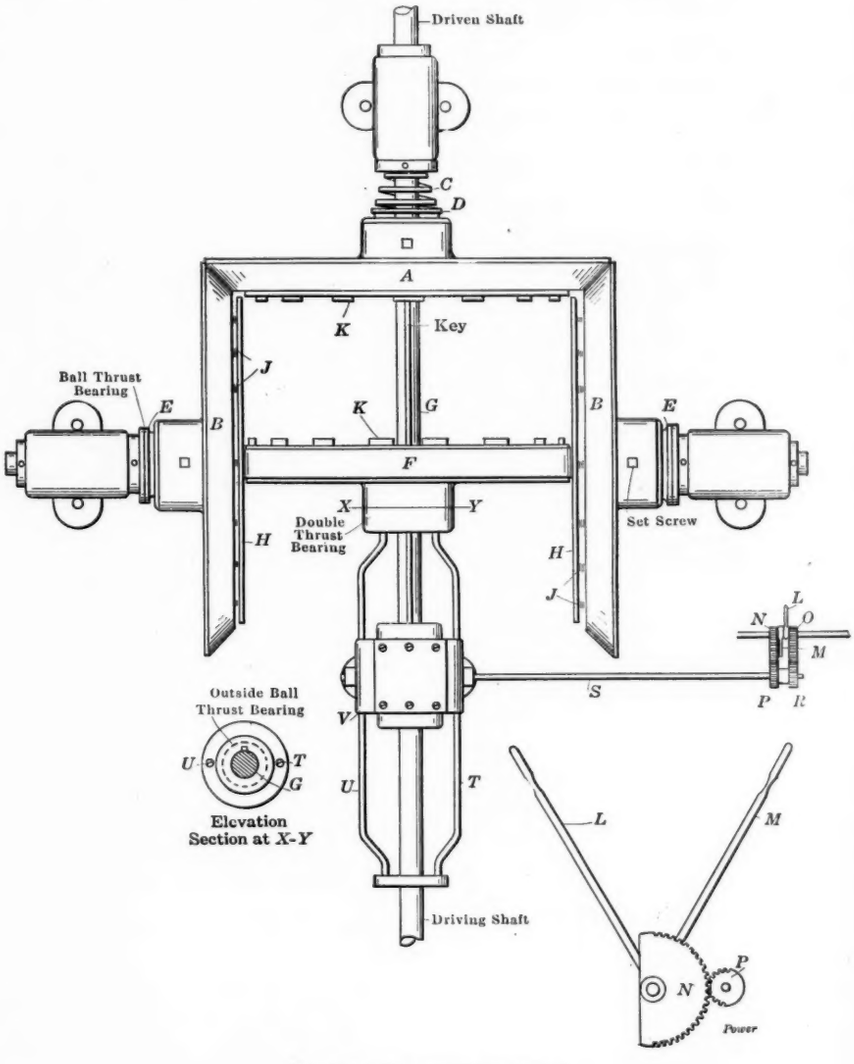
The main driving pulley *A* is feather-keyed to the engine shaft, and is set to bear against the pulleys *B B* by the spring *C*, the tension of which is regulated by the threaded steel bushing *D*. The pulleys *B B* are also feather-keyed to their respective shafts, but are set out by backing the threaded steel bushings *E E* against a thrust bearing. The pulley *F* travels on the shaft *G*, and is revolved by contact with the aluminum-faced friction disks *H H*. These disks are set out by the short, stiff independent springs *J*, which are wound around steel driving pins. This method precludes the tendency of the bearing pressures of the disks *H* to throw the pulleys *B* from contact with the pulley *A*.

As the pulley *F* slides toward the pulley *A*, the speed of the driven shafting increases, so that when they are within an inch or so of each other, the difference in speed is very slight. If, therefore, the lugs *K* on the pulleys be brought together, the driving and the driven shafts will be coupled together, and the contact will be made without danger of shock, and the pulleys *B B* and *F* are relieved of all wearing strains on their frictional surfaces.

The shaft *G* has a hardened-steel roller bearing contained in the wood filler of pulley *A*.

The method of control is as follows: The two controlling levers *L* and *M*, one for the forward, the other for the reverse, operate the semi-gears *N* and *O*, which in turn revolve the small gears *P* and *R* and the shaft *S*. The side rods *T* and *U* have teeth cut on their lower faces which mesh with small gears keyed to the shaft *S*. The casting *V* is bolted to the journal of the shaft *G*, and forms a bearing for the side rods and the shaft *S*. Each of the controlling levers *L* and *M* actuates its respective semi-gears by means of two pawls, one for the forward movement and one for the reverse. When at their extreme throw, the levers have a slight lost motion, which allows a small cam to engage with one of the pawls on the other lever. Thus when one lever is engaged the other is inoperative.

I am aware that the design of the friction drive could be improved, but, as it is homemade, the patterns had to be very simple, such as I could turn out myself, and one pattern had to do for the four main bearings, and one for the four friction pulleys.



DETAILS OF FRICTION DRIVE

R. O. RICHARDS.

Framingham, Mass.

Pipe covering which has become unsightly and soiled can be made to look as good as new by first removing all loose dust and giving it a coat of whitewash in which enough salt has been dissolved so that it will not rub off.

Questions Before the House

Uncle Pegleg on Velocity

Uncle Pegleg's lectures upon the philosophy of mechanics are always interesting and instructive, as well as amusing. I have just run across one of his points, however, which has set me to figuring. It was published in the August 23 issue.

In this lecture, Uncle Pegleg was endeavoring to fix in mind the fact that it is only *change* in velocity, not velocity itself, which absorbs force and energy—which is true enough. To bring this home he called attention to the contrast in the work apparently to be performed by two baseball pitchers, one using the North Pole as his box and the other standing on the equator and pitching east. The latter would be sending balls through space at a velocity greater than that of rotation of the earth's surface—which would be a pretty hot ball for a batter to find.

But, Uncle Pegleg pointed out, the pitcher at the equator does not send the ball out of the box, nor over the bag, at this enormous velocity. The only velocity in which pitcher, batter and catcher are concerned is that of the ball *relative* to that of the earth's surface.

So far very good. But here comes the puzzle. The energy required to alter the velocity of a body, such as a baseball, is not proportional to the difference between original and later velocity only, but to the difference between the original and later velocities *squared*.

Thus, proceeding to figures, the mass of a baseball, or its weight divided by the acceleration of gravity, 32.16, is just about 0.01. If we assume the "muzzle velocity" of the ball to be 60 feet per second; that is, the speed which the pitcher imparts to the ball, the usual formula for energy absorbed is,

$$\tfrac{1}{2}\ M\ V^2 = \tfrac{1}{2} \times 0.01 \times 3600 = 18$$
foot-pounds of energy.

From this we can figure the power developed by the pitcher, by assuming that his hand makes a stroke of 6 feet in starting the ball into motion. If its motion increases steadily the *average* velocity of the ball, while it is in his hand, will be

$$\tfrac{1}{2} \times 60 = 30 \textit{ feet per second,}$$

and the time taken in starting the ball will be

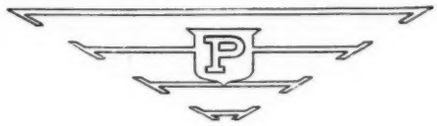
$$6 \div 30 = \tfrac{1}{5} \textit{ second.}$$

Hence, the power developed equals

$$18 \div \tfrac{1}{5} \div 550 = 0.1635 \textit{ horsepower.}$$

This is only the power absorbed in starting the ball. As the pitcher also has to start into motion his hand, arm and the rest of his body, the real power must be

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.



several times this figure—probably about one horsepower.

But, the above figures apply only to the pitcher at the North Pole. How about the one at the equator, facing east? He has to impart to a ball already possessing the velocity of the earth's surface, or about 1500 feet per second, an *additional* velocity of 60 feet per second, bringing its final velocity up to 1560 feet per second. How much energy will this take, and what power must the pitcher develop?

Using the same formula as before, the energy equals

$$\tfrac{1}{2}\ M\ V^2 - \tfrac{1}{2}\ M\ U^2 = \tfrac{1}{2}\ M\ (V^2 - U^2)$$

wherein, $U = 1500$ and $V = 1560$ feet per second respectively. According to this, the energy equals

$$\tfrac{1}{2} \times 0.01 \times (2{,}433{,}600 - 2{,}250{,}000) = \tfrac{1}{2} \times 0.01 \times 183{,}600 = 918$$
foot-pounds.

But this is 51 times as large as before!

The power developed by the pitcher must have increased in like proportion, so that the power going into the ball is now 8.34 horsepower, while that developed by the man must be about fifty horsepower! They must use stalwart baseball players on the Orinoco Giants! Eleven innings of exertion at the rate of fifty horsepower would try a man.

This does not look quite right, Uncle Pegleg, but it is figured according to "Hoyle." What is the explanation?

SIDNEY A. REEVE.

New York City.

The explanation is that you charge the pitcher with the velocity which the ball already has but do not credit him with the velocity which *he* already has.

The question is, how much energy is required to get the ball into motion at a certain velocity *relative to that of the pitcher* or to that of the earth on which he stands.

To get the ball into motion from rest at a velocity of 60 feet per second would take, as you say,

$$\frac{M\ V^2}{2} \text{ or } \frac{0.01 \times 60^2}{2} = 18 \textit{ foot-pounds}$$

You assume that the "stroke" is 6 feet, in which case the average force which he exerts on the ball must be

$$\frac{18}{6} = 3 \textit{ pounds}$$

To get the ball into motion at the velocity of the earth's surface at the equator, say, 1500 feet per second would require

$$\frac{M\ V^2}{2} = \frac{0.01 \times 1500^2}{2} = 11{,}250 \textit{ foot-pounds}$$

and at 1560 feet per second

$$\frac{0.01 \times 1560^2}{2} = 12{,}168 \textit{ foot-pounds}$$

The difference is

$$12{,}168 - 11{,}250 = 918 \textit{ foot-pounds,}$$

or 900 foot-pounds more than when the motion of the earth was not considered.

The 18 foot-pounds was developed by the movement of the pitcher's arm through 6 feet relative to the earth's surface, with an average pressure of three pounds. This action required, as you figure,

$$\frac{6}{60 \times \frac{1}{2}} = \tfrac{1}{5} \textit{ second}$$

In one-fifth of a second, the earth and the pitcher, *and his hand, bearing on the ball with a force of 3 pounds,* will move through

$$\frac{1500}{5} = 300 \textit{ feet}$$

and this pressure exerted through this distance is the additional 900 foot-pounds which you introduce when you refer the movement to a point with reference to which the earth's surface is moving at a velocity of 1500 feet per second instead of to the surface of the earth itself or to the pitcher standing upon it.

UNCLE PEGLEG.

Central Station vs. Isolated Plant

I noticed in a recent issue an account of a meeting for the purpose of discussing the encroachment of the central station upon the field of the isolated or individually owned power plant. The speakers dealt in statistics, the results of carefully conducted experiments tending to prove that the isolated plant could furnish power cheaper than the central station. There is where the owner of the individually owned plant has the engineer at his mercy (although he may not yet know his power to hold him to the mark), for he must make good and in order to resist the encroachments of the central-power plant and hold his job. Although one or more experiments may not "prove all things," yet it is enough to show the mark which every engineer must strive to attain in order to hold not

only his position but the standard of living he has set for himself. As I cannot intelligently or otherwise dispute the statistics submitted, the individually owned plant seems to have the vantage ground. I look upon the encroachment of the central station as irresistible, it is the usual development—or centralization, but, of course, it is of vital importance to the large body of engineers to keep this encroachment back as long as possible, for it means for them a subordinate position and a lower wage scale, and consequently a lower standard of living. In my opinion the large central station of the future will be operated by a small staff of experts in their line, men who can demonstrate both scientifically and practically the highest specialization of the art of engineering and who will have under them men who are now masters (but not owners of the plants they operate)—therefore it is, as I stated before, up to the engineering vocation as a whole to fight for its preservation as long as it can, and by giving to the owners of isolated plants a maximum of power for a minimum of outlay demonstrate that it is the better investment.

But the question that puzzles me is how long will this, the very foundation of all other industries, remain without the pale of centralization.

H. A. D'ORSAY.

Lynn, Mass.

Reverse Drive

In the issue of November 1, I noticed on page 1949 that S. McRae recommends a reverse drive to take the place of a cross-belt drive. The way in which he has it laid out will reverse the drive and will, as he says, be a straight running belt, provided the pulleys are in line. It seems to me, however, that he

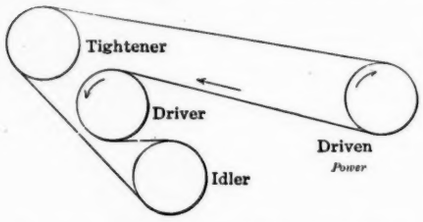


DIAGRAM OF CORRECT REVERSE DRIVE

does not realize that the first pull comes on the idler, which makes it hard on the bearings, creating friction and decreasing power.

A belt should never pull on the idler if there is any way to get out of it, as such an arrangement will always give trouble and require 50 per cent. more oil to keep it in running condition.

The accompanying figure shows a correct layout for a reverse drive. The pull is direct from the driver to the driven. The slack side of the belt runs to the idler and then to the tightener. This arrangement is light on the bearings and does not create half as much friction as Mr. McRae's arrangement. Also, the belt will last much longer and the drive will give less trouble.

With my arrangement the contact area on the driven pulley is even more ample than that on the driver. I have used a drive of this design for eight years and have never had any serious trouble with it.

T. J. MCNULTY.

Brookhaven, Miss.

Water in the Ashpits

In the October 18 number, Henry Perlman asks the opinions of other readers about the practice of having water in the ashpits. On several sugar plantations where I acted as assistant engineer, we had trouble with clinkers sticking to the grate bars, on account of dirt in the coal, and we had to pull the fires every three or four hours. I suggested to the chief that water be put in the ashpits, as I had done the same thing in the American navy and got good results. He had the same objections to offer as did the superintendent Mr. Perlman speaks of; but, at last, he told me to go ahead.

The practice was kept up for the subsequent two years that I remained there and for three or four years after that, until oil firing was adopted. The original bricks are still in the settings. So much for the softening effect on the brick.

Now, as to the effect on the clinkers. When I was in the navy, on a ship doing service in Hawaiian waters, we burned coal which came from Sydney. It was the dirtiest coal I ever handled. We had to blow the tubes out every half hour and break up the clinkers about five times in a watch of four hours.

I went to the chief engineer and asked him to let me try putting water in the ashpits, as I had heard that then the clinkers would not form so quickly, neither would they stick so hard to the grate bars. He told me to try it because, as it was, the fire-room force could not keep up steam. It took two men with a strong slice bar to break loose some of the clinkers before we tried the water in the ashpits. After that, by running the bar through the fire once an hour, we could keep going for a whole watch without cleaning fires.

W. ELLERBROCK.

Honolulu, Hawaii.

Writers among Engineers

I noticed the inquiry in the October 25 number, "Why Are There Not More Writers among Engineers?"

I think that one principal reason is that we simply do not sit down and go at it. It seems to be quite a task for some people to write letters. I know that I am in that class.

I am in charge of a plant in which there is one 18x42-inch Hamilton Corliss engine, two return-tubular boilers, one a 80- and one a 150-horsepower. This equipment furnishes part of the power for the factory. The balance is furnished by a three-cylinder vertical gas engine, operating on a four-stroke cycle with make-and-break ignition. This engine is belted to a 100-kilowatt generator. And, then, there are the usual auxiliaries necessary for both steam and gas prime movers.

Naturally, I am on the lookout for any information pertaining to such a combination of prime movers in general, and especially to gas engines, gas producers, etc. We are using natural gas now, but we may some time have to install a producer.

W. D. HOLLISTER.

Perry, N. Y.

Having read Mr. Gage's letter in the October 25 issue, I would like to say that I have often wondered why there are not more writers among engineers.

It is true that there must be men all over the country who could teach a good many of us quite a few things by relating little experiences encountered by them from time to time.

Strange to say, there are comparatively few engineers who show any desire to put their experiences on record, even when the subject is mentioned to them. It is not because they cannot, but because they will not talk upon the matter. Hence it is that the young man who is starting out as an oiler or fireman meets with so many obstacles.

It would seem from this that there is a certain feeling existing that cannot be called by any other name than jealousy. This is probably due to a feeling that the man who is seeking information is also seeking the other fellow's job. Allowing this to be so, is it not of equal benefit to both parties, for then the man who is being questioned should sit up and take notice before the other fellow takes his job.

Mr. Gage mentions the mixing of cement and asbestos in equal parts for pipe coverings, etc. It has been my experience that in cases of this kind where a leak develops, the water traverses the pipe for some distance from the place where the leak occurs before showing through, and when the covering is removed, the leak is found not at the place suspected but somewhere else.

In regard to the business end of a plant, I do not consider any plant is being run properly unless the engineer keeps a daily record of the work the plant is doing. It is his place to be able to tell his employer what is being done when the question is put to him. The method of keeping records can best be determined by a study of the plant and its needs.

Referring to Mr. Vedder's letter in the November 22 issue, which I read with

interest, I want to say that I do not agree with him when he says that every man, including the first assistant engineer, should have a definite amount of bright work, floor area, etc., to clean. The duties of the first assistant engineer as I understand them are to keep the apparatus in the plant in first-class running order. Now, if in addition to this he is expected to clean bright work, floors, etc., I would not like to be in his position.

I do agree with him, however, when he says that the chief engineer should have no "pets," for if he does, the plant is bound to suffer.

H. H. BURLEY.

Brooklyn, N. Y.

Treatment of Subordinates

In regard to H. R. Rockwell's letter in November 15 issue, I think, as he does, that the engineers who find fault with their men simply to show their authority, lack good sense and principle.

As a sample of this class, I recall a man who was operating engineer on the shift on which I was fireman. The first night we worked together he took special pains to inform me that he was the boss and cautioned me not to forget it; this, without having even given me an opportunity to become acquainted with him. One glance was sufficient for me to notice his size and nationality, and convince me that I had better not dispute his claim. And I did not until one night after I had reported to him that one of the boilers had developed a leak under a rivet head. He came downstairs with a 12-pound sledge and a calking tool to calk the leak with 125 pounds steam pressure in the boiler. For a few minutes I forgot that he was the boss, and it was only after I had threatened to telephone to the chief that he agreed not to attempt to do the job.

Unless this man acquires more common sense and better judgment before he becomes "the boss" in reality, he will not be a safe man to work under.

To illustrate the right kind of engineer, here is an instance which came to my notice recently.

A young man, ambitious to get experience in another branch of the profession, had an opportunity to go to another plant and was about to take leave of the engineer under whom he had served as fireman for about six months.

The young man, taking the hand of his superior, said, "Well, Mr. ———, you are the best engineer I have ever worked for and I shall consider myself fortunate if ever I have a chance to work for you again."

The engineer replied, "You have been a good man for me, you have always done your work to the best of your ability and, while I am glad to see you advancing, I am sorry to lose you. If you need a recommendation, I shall be pleased to say a good word for you. I want you to keep in touch with me and, if ever I have a vacancy which you can fill, I shall certainly give you a chance." And, having said good-bye and exchanged best wishes, they parted. To the man who sees everything from the viewpoint of dollars and cents, this may seem like foolish sentiment, but it is not; it is a feeling of good fellowship which exists between men who have used each other right, and is never the result of tyranny or mean treatment.

During my experience I have worked for two chief engineers who were considerate of the men under them and had the courage to let that fact become known even to their employers, but I have worked for enough of the other kind to enable me to fully appreciate the right sort when I meet one.

J. A. LEVY.

Greenfield, Mass.

I read with interest the letters of Mr. Westerfield and Mr. Rockwell, in the November 15 issue of POWER, on the treatment of help.

I always try to treat my help in the same way that I would expect to be treated if I were in their places.

I never believe that a "grouch" gains anything, for the majority of men will do good work if you give them credit for what they do properly and not scold them if they make an occasional mistake. We all make mistakes. It happens sometimes, though, that men cannot stand humane treatment and get to thinking that their superior is not of much importance if he is not mean to them. The consequence is that they get to doing as they please. If you give such men an inch they will take a foot. If you try to correct them in their mistakes, they become offended and "fly off the handle" right away. Therefore, as Mr. Westerfield says, the best thing to do with men of that kind is to get rid of them, for there are plenty of men who can be induced to do what is right.

I have a man with me now, who put his first fire in a furnace for me a little over two years ago. He is now second engineer and giving good service. The first day he was with me he said that he did not know anything about a steam plant and that I would have to "show" him. I told him that he was just the man I wanted and if he would listen to me and do as I told him we would have no trouble. He did, and is still of the same attitude that he was on the first day.

He looks to me for advice and expects me to tell him, and when I tell him he listens and tries to do as he is told. He never acquired a "swelled head" nor got to thinking that he knew it all. We have never had a misunderstanding.

WALTER CARR.

Harrisburg, Ill.

Hotel Power Costs

Having read the editorial in the November 8 issue relating to power cost in hotels, I beg to submit some figures on the cost of power at the Hotel Rochester.

The plant is two and one-half years old and has been under my charge since it was installed. The equipment is as follows:

Three 207-horsepower water-tube boilers. Three high-speed automatic engines, one of which is 11x12; one, 16x14 and one, 18x16 inches in size. To these are connected a 50-, a 100- and a 150-kilowatt generator respectively. One 14, 24 and 12 by 20-inch and one 16 and 10 by 16-inch elevator pump. Two 14 and 8¼ by 14-inch house-service pumps and two 7½ and 5 by 6-inch boiler-feed pumps. A 9x15-inch refrigerating machine driven by a 13½x12-inch engine.

The peak load on the electrical machinery is about 1400 amperes.

COST OF POWER FOR 1909.

Packing, water, repairs, sundries, etc.	$ 918.02
Oil and waste	277.88
Salary and labor, including wages of "repair man for the rooms" and man to handle ice in ice plant	6,110.95
Coal at $2.60 ton	9,706.80
10 per cent. interest and depreciation on power plant	2,803.00
Total	$19,816.65
Less heat, light and ice sold outside	3,379.45
Net cost	$16,437.20

Output of dynamos for year, 514,228 kilowatt-hours.

$$\frac{16,437.20}{514,228} = 3.2 \text{ cents per kilowatt-hour}$$

These figures include the cost of steam and repairs for the kitchen and laundry equipments, elevators and elevator pumping plant, ice plants, vacuum-cleaning apparatus, ventilating and heating equipment and hot water for the entire house. They do not, however, include the cost of lamp renewals, as this is charged directly against the rooms.

The following is the power cost for October, 1910, which is the best month we have had:

POWER COST FOR OCTOBER, 1910

Packing, oil, waste, water and incidentals, which item includes all cost of material except coal	$ 55.00
Coal at $2.60 ton	947.88
Labor	550.00
10 per cent. interest and depreciation.	234.00
Total	$ 1,786.88
Less amount sold (heat, light and ice)	562.23
Net	$ 1,224.65

This cost includes, as in the previous case, the cost of steam and repairs for the kitchen and laundry equipment, elevators, ice plant, etc.

FIRST COST OF POWER PLANT EQUIPMENT.

Engines and dynamos complete	$13,600.00
Boilers, stokers, stack and feed pumps complete	14,430.00
Heating and ventilating complete with pipe covering connections to and including work in kitchen and laundry—everything complete	22,970.00
Ice plant complete	12,500.00
Elevators and elevator pumping plant	29,250.00
Electric wiring and fixtures	17,620.00
	$110,370.00

Of this amount the only sum for interest and depreciation that could be charged against the lighting outfit would be that on the cost of the engines, dynamos and boilers complete, or $28,030.

WILLIAM J. BEDARD.

Rochester, N. Y.

An Engineer's View of "Graft"

In the November 22 issue appeared an article entitled, "The Perquisities of an Engineer," having for its object the exploitation of a recently formed organization of engineers, the purpose of which appears to be the segregation of engineers into two classes—the "blacklist," composed of those who accept what is termed a bribe, and the "honor roll," composed, presumably, of members who are to be listed as immune.

The article further states that the organization does not aim to interfere with or injure other organizations but has for its principle the abolition of "graft."

It would seem that had the founders of this organization had the redemption of the engineer from the dangers of grafting solely at heart, some established association could have been found whose aims and social status would be sufficiently high for its members to consent to incorporate into its teachings the tenets and principles of this new order, thereby enjoying whatever benefits might accrue.

The subject of "graft" has been pretty well threshed out by correspondents in POWER and it is generally conceded to be a vicious habit. It will be of interest to learn just how the new organization interprets the word. If accepting cigars or the usual tokens that are given in return for honest patronage are included in the category, I predict that the list of survivors on the "roll of honor" will be short.

The owner of a local factory during a heart to heart talk with a newly hired engineer expressed a somewhat original view of the subject. He said: "When buying supplies I expect you to use your best judgment as to what supplies are necessary, the quality, price and quantity. I want you to keep on hand everything in reason that pertains to the satisfactory operation of the plant in such quantities as will be economical. Don't buy a large quantity of something that will dry up or spoil because a large order costs a little less. And don't let the salesmen 'get a rope on you.'"

The engineer hastily assured him that he was not in the habit of accepting "graft" from salesmen.

"You needn't call it graft," the employer resumed. "If you order right and see that you get what you order you need not be afraid to accept any present the salesman may offer. The price to me is just the same and I keep as close a watch on this department as I do on the rest, so if the orders are not right or if the plant is not kept up, you will surely hear from me. If you feel any compunctions regarding what you call graft, you can accept it and turn it in at the office. That will be better than leaving it in the hands of the salesmen."

In justice to the engineer, I will say that up to date no returns have been made to the office, and the best of feeling prevails. The engineer and employer invariably consult as to what and where to buy and the price to be paid.

The organization and the editorial referred to may have been inspired by an effort to uplift the benighted engineer, but it looks as though the sales people and not the engineer or the employer are the ones to benefit by a too critical view of what constitutes a bribe.

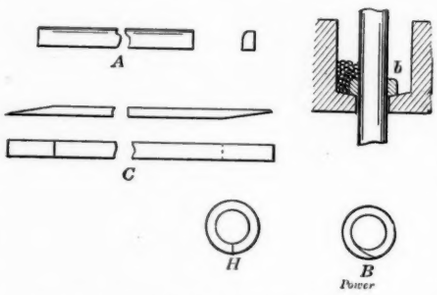
AMOS SKEG.

Saugus, Mass.

Trouble with Metallic Packing

I read with interest Mr. Chapman's account in the November 1 issue of the trouble he has been having with metallic packing.

When an engine is shut down for any length of time, the piston should be taken out and the cylinder given a heavy coat of oil or grease. I suppose that this was done in this case. When the piston was taken out the copper wire was probably moved a little, thus giving the packing a chance to work out through the clearance between the rod and the back of the stuffing box. A piece of copper wire is not very satisfactory as a bushing as it will not follow up the wear of the rod and thus it leaves a space through which the packing may work out. A small copper bar with one corner rounded off, as shown at *A* in the figure, will work better. The pressure of the packing on the curved surface *b* of the ring will cause it to stay close to the piston and thus prevent any leakage of packing past the ring. The bar should be annealed and the ends filed down as shown at *C*, so that they will fit together as shown at *B*. The ends can then slip a little as the wear is taken up around the rod, while if the ends were left as shown at *H*, the ring would not follow up the wear of the rod.



BUSHING FOR METALLIC PACKING

R. L. RAYBURN.

Kansas City, Mo.

Furnace Design

In POWER for November 22, D. G. B. asks for a rule for finding the proper distance between the grates and the shell of a horizontal tubular boiler. In the answer given it is stated that this distance should not be less than the diameter of the boiler. I think that the distance should be about equal to the radius, or half the diameter of the boiler, or, at most, not over three-fifths of the diameter of the boiler for hand-fired furnaces and bituminous coal. Even with a distance equal to only two-fifths of the diameter of the shell good results have been secured when the chimney draft was not less than three-tenths of an inch, water gage.

In the November 15 issue there is an article by D. F. Randall which was very interesting to me. Mr. Randall did not give his opinion as to whether the use of full arches from the boiler front to the back end of the shell is a detriment to the boilers. I know of many engineers who say that it is, based on the experience they have had with leaky tubes.

G. A. GUSTAFSON.

Chicago, Ill.

Feeding Boilers

My article under the above heading, printed in POWER for October 18, received a severe raking over by Mr. Willie in the November 22 issue.

Be Mr. Willie right or wrong, these facts cannot be disputed: This type of feed has been in use for two years on my boilers; no such trouble as Mr. Willie describes has happened so far. Furthermore, this feed was suggested by an inspector from a reputable insurance company which carries quite a few risks in that part of the country where Mr. Willie resides; namely, Massachusetts.

However, I would like to see this matter thrashed out. I do not want any cracked plates or burnt sheets. As Mr. Willie says, the danger exists and it is good practice and common sense to guard against it. As for the coolest part of the boiler, is it not at a point close to the uptake? Take the temperatures of the gases in the front part of the tubes and in the rear; a blind man could "see" the difference in temperature.

Any suggestions as to the merits of this method of feed will be welcomed. What has T. T. Parker, of New York, to say?

A. RATHMAN.

Chicago, Ill.

Annual Meeting Mechanical Engineers

Most successful meeting of recent years. Large attendance listens to a number of valuable papers. Col. E. D. Meier elected president.

The fall meeting of the American Society of Mechanical Engineers was held at the Engineering Societies building, New York City, December 6 to 9, and was one of the largest and most successful meetings of recent years. Increased importance was given to the opening session on Tuesday evening by holding the formal reception of the president and president-elect after the session at which the president's address was presented, a concert being furnished and a collation being served.

Retiring President's Address

The address of the retiring president, George Westinghouse, was of particular interest, in that it contained the story of his invention of the air brake. Having been delayed by a collision, his mind was directed to the important saving which could be effected in life, property and time by the application of effective mechanically operated brakes to the trains. He worked at first with chain brakes operated by a steam-actuated cylinder on the locomotive, but this was ineffective for a sufficient length of train. He then tried placing a cylinder beneath each car, furnishing the steam through a flexible coupling, but this failed because even in warm weather it was found impossible to transmit the required pressure to the rear end. He finally saw in a mechanical paper an account of the use of compressed air for operating the drills in tunnel construction, and this suggested the use of that medium for the brake. An account of various tests of the device, the organization of the Westinghouse Air Brake Company and the various developments which have followed the use of the brake followed.

Mr. Westinghouse also earnestly urged uniformity in the electrification of railways, pleading not for the adoption of any particular system, but for uniformity and interchangeability. With the growing use of electricity by the railways, this is a subject which will have as much importance in the early future as the adoption of standard gages and equipments did in the early days of railroading.

The secretary then announced the election of Col. E. D. Meier as president for the ensuing year. Following this introduction, the meeting, which was held in the auditorium, adjourned to the rooms of the society in the same building, where an opportunity was afforded to meet the retiring and newly elected president at the formal reception above referred to.

Officers Elected

The business session of the society was held on Wednesday morning. The tellers of election announced the election of the following officers for the succeeding terms: For president, E. D. Meier; for vice-presidents, H. H. Vaughan, E. M. Herr, George M. Brill; for managers, D. F. Crawford, E. B. Katte, Stanley G. Flagg, Jr.; for treasurer, William H. Wiley.

Wednesday Morning

Past-president W. R. Warner reported regarding the Land and Building fund and an amendment was adopted bringing the constitution into accord with the articles of incorporation. The subject of the importance of an engineering museum was brought up by Doctor Hutton and discussed, and Mr. Gilbreth suggested the importance of a department or committee of industrial management. President Meier commented favorably upon the address of the retiring president and a rising vote of thanks to Mr. Westinghouse was passed. President Meier also announced the death of William H. Bryan, of St. Louis, one of the active members of the society. Mr. Bryan had recently been appointed as engineer to the school board of Chicago, after a competitive examination, and the news of his sudden removal was universally deplored.

Prof. F. R. Hutton, honorary secretary of the society, and one of the official representatives of the society at the English meeting, presented a verbal account of the visit, and Calvin W. Rice, the secretary, presented, with a few supplementary and explanatory remarks, his printed account of the occasion. James M. Dodge presented a progress report for the committee on public relation.

The paper by George A. Orrok on the transmission of heat in surface condensation, abstracted in our issue of December 13, was then presented and discussed.

Transmission of Heat in Surface Condensation

Prof. W. F. M. Goss: It seems to me that in general there is no more prolific field for engineering research today than that touched on by this paper of Mr. Orrok's, that which deals with the effect on heat transference and of the philosophy of the fluids involved. The time is near at hand when we are going to very much enlarge our conceptions as to what may be done with a given area of heat-transmitting surface through controlling the velocities of flow over these surfaces. As a contribution touching this very important field, I look upon the paper of Mr. Orrok as one of very great value.

Professor Ennis: I should like to ask Mr. Orrok, first, as to how he rated the flow in comparison with the size of the apparatus compared with that in a modern large-surface condenser?

Mr. Orrok: I think we kept within the condenser limits—that is, I went as high as 10 or 11 feet a second, and kept down as low as one foot a second; that is, all of the experiments are within the condensing range. We did run one set of experiments at 4 or 5 inches vacuum, and succeeded in condensing 220 pounds of steam per square foot of surface, and I think that is double what has been done before, but so far as the conditions are concerned, they are within absolute practice.

Professor Ennis: I could wish that a little discussion had been put in the paper on the question of tube thickness, and two or three other practical questions. Take the matter of oxidization. Mr. Orrok lays some stress on oxidation as a determining factor, although Joule regarded oxidation as of light influence. The question is both technical and commercial at this point. We have oxidation on the one hand, and the transmission coefficient on the other hand, and on top of that a large number of purely commercial factors. The question of oil cutting in reciprocating-engine installations would be one of the factors presumably taken care of by the cleanliness coefficient d, but for which we have no data in the figures. What I would like would be to have Mr. Orrok say what kind of a tube he would use, for example, in his own practice here in New York with salt water for condensing, but he does not tell us quite that.

H. H. Suplee: Mr. Orrok has called attention to the important influence of the presence of air, and he has quoted also the paper of Mr. Morrison before the Institution of Naval Architects. Mr. Morrison, if I recollect, called attention to the fact that it was not only the presence of the air that exerted the influence, but its location. The tendency of air which leaks in is simply to crowd out the steam, and also the vacuum, but the influence of air contained in the water is to clinker the tube. Mr. Orrok speaks of a condenser consisting of a single tube, through which the cooling water is flowing, surrounded by an atmosphere of steam. Condensation, he continues, will take place at the outer surface of the tube and the steam will rush in to the tube from all sides. That is what Mr.

Morrison said, but that the air of the steam will rush to the tube, and the result is that the outside of the tube is immediately covered with bubbles of air, as we see bubbles of carbonic-acid gas clinging to the side of a siphon. That forms a nonconducting surface and cuts down the condensing value of the tube, and that does more harm than the air leaking through by degrees—more harm than anything else. Mr. Morrison said that the proper thing to do is to keep the tube swept clean of air, as we have scrapers on boilers to scrape the soot off. He thought if there was some moving back and forth through the length of the tube, brushing away the bubbles of air, the efficiency would be increased greatly. It is the location of air, and until you know about that your other determinations are almost certain to be irregular.

Thomas C. McBride: The writer is particularly interested in the author's experience as to the effect of air mixed with the steam, and the fact that this air, apparently from an unknown cause, varied in amount so greatly in the apparatus as at first constructed and connected that the results did not seem to be constant enough to have any scientific value. The conditions of these first tests were apparently, however, those which we meet in low-pressure turbine practice, and it seems therefore to the writer that they should have a practical value. It is hoped that the author will explain more fully the origin of the exhaust steam used in the apparatus as first constructed, and his conclusions as to what might have been expected from it as revealed by his tests, if used on low-pressure turbine work.

If, as the author states, the partial air pressure in his apparatus approached ¼ inch of mercury, the results obtained can hardly be considered as applying to practical conditions in surface condensers. In the writer's opinion, the heat-transfer results obtained indicate very much less air, this opinion being based on the heat-transfer results obtained and air condition existing in surface-condenser plants. Any condenser having as much as ¼-inch air pressure would require a vacuum pump of a size that would be prohibitive. As an example, if we presume the condition usually existing in surface condensers carrying 26-inch vacuum where it is presumed that the temperature of the water, steam and air passing to the vacuum pump is 110 degrees, one volume of air at its individual pressure of ¼ inch and temperature of 123 degrees, to which the steam temperature has been reduced by its pressure, will become after passing through the condenser at its temperature of 110 degrees and individual pressure of 1.4 inches:

$$\frac{0.25}{1.40} \times \frac{459.5 + 110}{459.5 + 123} = 0.174$$

Similarly this one volume of steam at its individual pressure of 3¾ inches before reaching the condenser has a volume 11,687 times that of the corresponding water.

The ratio of the effective displacement of the air pump and the boiler-feed pump required to handle this air will be

$$\frac{0.174}{\frac{1}{11,687}} = 2033$$

The usual practice of manufacturers of these conditions is an air-pump ratio of 13 to 1.

Similarly presuming ¼-inch air pressure in the exhaust steam with 28-inch vacuum in the steam-turbine work and that a separate cooler and rotative dry-vacuum pump are used, assuming also that the mixture of air and steam passes from the condenser to the rotative dry-vacuum pump at a temperature of 75 degrees, one volume of air as it exists in the exhaust pipe at its individual pressure of ¼ inch and temperature of 97 degrees will have, after leaving the condenser, an individual pressure of 1.13 inches and a temperature of 75 degrees and therefore become

$$\frac{0.25}{1.13} \times \frac{459.5 + 75}{459.5 + 97} = 0.212$$

volumes. The volume of steam in the exhaust pipe at its individual pressure of 1¾ inches will in its condensation be reduced in volume about 23,875 times, or the ratio of the effective displacement of the rotative dry-vacuum pump to the boiler-feed pump must be

$$\frac{\frac{212}{1}}{23,875} = 5060$$

This, again, is prohibitive, representing a vacuum-pump displacement 200 times or 300 times that usually found necessary in steam-turbine condenser work.

Accepting Mr. Smith's statement that the effective displacement of the rotative dry-vacuum pump must be about 20 times the displacement of the feed pump, we can calculate the amount of air presupposed by this statement to be mixed with the steam on its way to the condenser. Using the same assumptions as above for 28-inch vacuum, one volume of water in the feed pump becomes about 21,500 volumes on its way to the condenser; 20 volumes of air passing from the condenser to the rotative dry-vacuum pump at its temperature of 75 degrees and individual pressure of 1.13 inches would have, when mixed with the steam before condensation, a volume of 21,500 and temperature practically 101.4 degrees. Neglecting the slight increase in volume by change of temperature, the individual pressure of this air in the exhaust pipe must then have been

$$\frac{20}{21,500} \times 1.13 = 0.00105 \text{ } \textit{inch}$$

The relative volumes of the air and steam in the exhaust pipe if separated would therefore be as 0.00105 to 2, or a ratio of 0.00052. In other words, Mr. Smith's conclusions as to the rotative dry-vacuum pump capacity that should be used involve 5.2 volumes of air mixed with 10,000 volumes of steam in the pipe leading to the condenser and a considerably lower air pressure than he has stated when operating under the conditions assumed.

These questions suggest the advisability of the society adopting some sort of a standard code or standard method of testing large condensers, particularly as refers to the question of the amount of air present and the influence of this air on the results obtained, and it is believed by the writer that much useful work could be accomplished by the society in establishing some code.

Mr. Orrok: Professor Ennis speaks about the thickness of the tube—most of the tubes which we tested were of the same thickness, 18 gage; I had some 16 and some 20. I could not determine any difference between 16-, 18- and 20-gage tubes. In fact, my own idea is that I do not think I could have detected much difference between 12 and 20, and perhaps even larger. I think we never used a tube up to the limit of its capacity.

Regarding the oxidation problem, I suppose we tested fifteen or twenty tubes in various stages of observation. On page 2205 of the December 13 number of POWER the two lower curves in Fig. 3 represent, one a new Admiralty tube, that is, the one that U equals 308, and the one below, at 224, an old Admiralty tube that has been oxidized. How much oxidized, I would not like to state. If you should plot every heat transmission experiment there, and then try to draw a mean through the center, you would probably get somewhere within 0.05 on either side of the one-half, that is, it would go from 0.45 to 0.55 for the exponent. Professor Ennis thinks my variation there is quite large. I acknowledge it is large, but it is more than we were able to get in any other way, and I hope some day to make it smaller yet, but at present do not see my way to do it.

Mr. McBride wishes to know where our exhaust steam came from. That is the exhaust steam from blower engines and such auxiliaries turned into a large main running the length of the station, and tubes taken from that into open heaters. The chances for air are large, and I have no doubt there was air. Why do I say ¼ inch at the main? That is an estimate. I tried thermometers and pressure gages and almost every other means at my disposal to tell how much air I had there, and, while I could be sure of it for one minute, I could not be certain of it for more than one minute. I found by reading Mr. Smith's paper that he had exactly the same condition, and worked six months to get the gal-

vanized-iron tank tight, and after he soldered the edges and tarred them, he found the soldered tank would not hold tight and air would get in. In our case the boiler, so called, was made of a couple of 14-inch 200-pound steam-heater steel plates. I have no doubt air came through the pores of that steel at a greater or less degree at that vacuum. As to the pipe that I used for the condenser and the connections, I have no doubt that this leaked air under vacuum conditions. I had two 1-inch air lines running to a big dry-vacuum pump and a condenser, and I was pretty certain of the flow of steam through the pipe, so that there was a continual current parallel with the tube to sweep that air out of the condenser, and even then I think I had air. We tried to find whether there was any variation of temperature within that fifth temperature tube that was the shell to the condenser. We put some thermometers in it and raised them up and down and put them close to the tube and close to the edges, and put the three checks along the length, and we could not find any difference in temperature any larger than about one-tenth of a degree. Now, I have found very much greater differences on a big condenser, but I think in the tube space, where the steam is, you can pretty nearly always find practically the same temperature.

Wednesday Afternoon

The session of Wednesday afternoon was presided over by Vice-president R. C. Carpenter, the first paper presented being that upon combustion and boiler efficiency by Edward A. Uhling, abstracted in our issue of December 13.

Discussion on Uehling Paper

O. H. Bathgate thought that a proximate analysis of coal is insufficient. A separate determination of sulphur is necessary to associate the quality of coal with efficient steam generation.

He agreed with the author that for daily boiler-room practice when the maximum CO_2 is likely to be below 12 or 13 per cent., the omission of the remaining gas constituents is not serious, and for the average fireman the simplifying of such matters tends to greater efficiency.

He believed that a plant where the CO_2 is determined either manually or automatically, should also provide a means for determining the carbon in the ash. Gas and ash analyses are equally essential to a complete knowledge of combustion, for in actual experience, he had found firemen sacrificing coal to the advantage of a high CO_2 record. This indicates that gas analysis in itself is not necessarily a true index of boiler efficiency.

He looked upon the various groups of the tabulated results with as much suspicion as does the author himself, who states that correct gas analysis, indicating furnace and boiler efficiency, depend on the composition of fuel, stack temperature and temperature at which analyses are made, and yet none of these important factors appear to have been given consideration. For this reason, inconsistent results would be expected, these varying with the conditions under which the analyses were made. If fewer results had been used and these corrected to a basis of standard fuel, temperature, etc., more reliable conclusions could have been derived.

Boiler-room efficiency can be increased by using a reliable CO_2 recording apparatus, but his experience with three different types and investigations of as many more had led to the conclusion that there is at present no practical automatic CO_2 apparatus available for continuous boiler-room operation.

To develop the highest efficiency, he would recommend running a single boiler on continuous test under strictly operating conditions, noting the quantities of steam generated and coal consumed and recording all conditions entering into the operation. Continuous gas-sampling vessels, coal and water meters; steam, water and gas temperature recorders are instruments whose practicability has been proved. With one man looking after these instruments, numerous records covering any desired period of time may be obtained. The result would determine the conditions necessary to effect the highest furnace and boiler efficiency. A CO_2 indicator and recorder would then be useful as an index of comparative operations and would be of material value only so long as the quality of coal and other controlling factors remained essentially the same.

Prof. William D. Ennis, of the Brooklyn Polytechnic, said: I do not believe that we can overestimate the importance of this subject. It is a vital thing in the power plant today, beside which such a matter as the steam turbine is a mere detail—but from an operating standpoint it is largely a matter of air leakage. How wholly it is a matter of air leakage I have recently had opportunity to determine. We took one of our boilers (making an effort to change nothing else) in its ordinary operating condition, and that was not very bad, and carefully plugged up all the air holes we could find in it. The result was that we increased the percentage of CO_2 from 4 to 11, simply by reducing the air leakage alone, no change in the method of firing, and this I estimate corresponds with an increase in boiler efficiency represented by the ratio 57 to 85—not that we got 85 per cent., but that is the ratio.

There are reasons—some were mentioned by Doctor Uehling—for measuring the CO_2 rather than the oxygen. One is that at reasonably good combustion efficiency, the percentage of oxygen gas is difficult to measure. There is another reason—that stratification in the furnace, that always occurs, results in the simultaneous presence of oxygen and carbon monoxide, and you might get one or the other, and any deduction you would form from the presence of one would be an unsafe deduction; but if you get an average sample of CO_2 across the furnace, you get something that represents the facts. CO_2 measurements usually tell that something is wrong, but not what is wrong. It is best to determine this by the oxygen and carbon monoxide, and we have an opportunity to check, since, as shown, the sum of this will be a constant, and if we had a coal containing no moisture, and air containing no moisture, the constant would be equal to the percentage of oxygen in the air by volume.

I must dissent from the opinion which has just been expressed that there is a comparatively low best percentage of CO_2. That may be technically and theoretically true, but in the power plant it has been my unvarying experience that the percentage of CO_2 of maximum economy is the highest we can get—that we cannot reach the point where we go the other way. If I am wrong, I would like to be corrected, as it is a practical point, but that is the state of my religion on the subject. We do not need to be afraid of going too far, or getting too high a percentage of CO_2. I would pay a fireman a bonus based on getting a high percentage of CO_2.

Professor Kent: Do you carry it above 15?

Professor Ennis: I have not gotten up to 15. You must remember that when we get to these high percentages, the increase in CO_2 from 15 to 16 does not mean much. A jump from 4 to 5 per cent. means six and a half times as much as would a jump from 11 to 12 per cent.

We have been trying some devices to get the CO_2 without using expensive automatic apparatus. We find in these machines the pipe gave considerable trouble. If the coal contained sulphur, we found a deposit in the pipe line, probably iron sulphate. That has been remedied by using copper pipes.

One of the claims made for automatic machines is that they give a constant indication of what is going on, yet in one plant we measured the pipe line, a ¼-inch pipe, 120 feet to the nearest boiler, and 180 feet to the farthest boiler, and by an ingenious method we measured the time required for the gas to travel from the different boilers to the machines. We found it took from five and a half to six minutes. In another plant, a ¾-inch pipe was used, 130 feet to the boiler, with a different type of instrument, intermittent sampling, and it took from four to sixteen and three-quarter minutes for the gas to reach the machine, and seventeen minutes for it to get through. I do not call that a constant indication. The fireman said that when

they had the best fires the machine showed the poorest CO_2.

We have not given up the notion of judging everything we need to know about boiler economy from the temperatures at the furnace and stack. Our present line of investigation is to take samples in a large container. First we used a glass bottle, and collected the gas over water. We got the average composition, and we found if we tested it at once there was 10 per cent. CO_2, but if we let it wait a couple of hours, we would get a smaller percentage of CO_2. We tried tin cans, shellac joints, etc., and we came to the conclusion that the water absorbs the CO_2 rapidly, and in looking up the information we could get from the builders of automatic machines, we found it was their practice to put salt in the water, so that it would not absorb the CO_2. We tried that, but we found that the water absorbed the CO_2 as much as ever. We made some experiments to see how rapid the absorption was. We found it very rapid at first, and then it slacked off somewhat, gave a sort of parabolic curve. The absorption was greatest if the initial percentage of CO_2 was high. By using a film of kerosene over the surface of the water we have cut down the rate of loss about one-third, and by making the analysis quickly after taking the sample, there is no loss.

Some of the automatic machines confine the sample in contact with water for twenty-four hours, and you can imagine how corrrect the determination of CO_2 is under those conditions. After working with two or three types of these machines, ever since they first appeared on the market, I have drawn a mental specification of what constitutes an ideal CO_2 recorder. It must be automatic; not too delicate; it must not be easy for the fireman to fake; must be continuous and not intermittent; must record and indicate its readings, and, I think, most important of all, it ought not to cost over 25 cents a boiler horsepower, and one ought to be put on every boiler in the United States.

Prof. William Kent: I am rather surprised that Mr. Uehling did not in his paper mention the improvement in boiler economy that can be obtained by autographic registration of the furnace temperature. Fifteen years ago I borrowed one of Mr. Uehling's instruments for that purpose, to determine continuously the furnace temperature. With the Uehling pyrometer and the Bristol recording gage attached to it, I could see at all times what the temperature was, as close as the individual recorder would give it, and that was pretty close. Whenever the pyrometer showed in the neighborhood of 3000 degrees in the furnace we had good economy, and when it went down we had rather poor economy.

There are some other principles of boiler economy which Mr. Uehling has not emphasized, and that is, if you want the best economy you must have dry coal. You must not have coal which will clinker and change the condition of the fire. This is rather more important than any theoretical efficiency regarding gas analysis or coal analysis.

Another thing I notice in the recent literature on the subject of boiler economy is that too much emphasis is placed on heat units, especially with anthracite coal and semi-bituminous coal. The semi-bituminous coals are usually uniform in quality—that is, they have between 15,000 and 16,000 B.t.u. per pound of combustible, and if you take 15,758 B.t.u. you are more nearly correct than if you send the coal to a chemist to have the B.t.u. determined. With the anthracite coal the heat value per pound of anthracite does not vary over 2 per cent. from the anthracite with 7 per cent. volatile matter down to 2 or 3 per cent. volatile matter, and it is not necessary to analyze, to get the approximate value of anthracite coal, except to determine the characteristics of the coal as regards ash. The salient features are how much moisture is there, and how much ash?

When you go beyond the semi-bituminous coals, the case is different. With the bituminous coals of Pittsburg and the far West the situation is different, and it is necessary to make an analysis of the volatile matter before we can make any general conclusions. The most important things, for a proper boiler test, are the continuous autographic record of the temperature of the furnace and a continuous autographic record of the CO_2 in the gases. After we have these, we have about all the indexes we need for boiler economy.

Prof. D. S. Jacobus: We have, as has been pointed out, more to lose and gain in the boiler plant of the power house of today than in any other place, and this idea of recording the analysis of the gases is all a move in the right direction. It should be remembered, however, that the gas analysis is not the only thing, and I will say a little bit more on that later on, but before leaving the gas-analysis part, I want to say several things. We have been talking and Mr. Uehling has shown that the CO_2 reading is the important item, yet we have found out, where we have to reach the ultimate in getting efficiency out of a boiler, in a test, that the hardest thing to do is to dodge the CO, that is, when we can readily get the CO_2 with a good fireman or stoker up to 12.5 to 14 per cent., with only a trace of CO, it is entirely a different proposition to get higher percentages without making CO. We did not appreciate that fact so much, until we were driven against it in this way. We started in by making ultimate analyses of the flue gases, where we give the hydrogen and the hydrocarbons, and we found we have been thinking all along of determining the CO_2; and where we record the CO_2, very often we might have 0.2, or we might have had 0.4, or sometimes as high as 0.75 of a per cent. of CO, and that 0.75 of a per cent. means a great deal in the economy.

At the present time in determining the CO_2 we use two absorption pipettes, running first through one, which is used continuously, and taking out what is left in the second—and we mix a fresh solution on the ground before we start to work, and make sure that the solutions are right.

Now, to consider some of the other places where you can lose and gain in boiler-room practice. There is as much loss in the average boiler room by running along with the boilers at a very low load during certain parts of the time as there is through excess air. There are two problems in the generation of power, one in the plant which is running continuously at a certain uniform load; the other, the ordinary power plant, where, we will say, you have a load running over a period of five hours, where the load starts up and goes to a peak early in the day, going down again, and then you will have another heavy peak, and you do not know when it is coming, and you must have enough boilers to carry you over the peak. The great problem, and where a good man will save expense as compared with another man, is in getting the boilers ready to meet these peak loads, and in that one particular as much can be lost and gained as in cutting down the air, or getting up the efficiency in the boilers while they are actually running. The modern practice tends more and more to run the boilers hard during the peak-load periods, because if you can carry over two or three hours of the peak, even at the sacrifice of some little efficiency, and thereby cut off one-third of the boilers in the plant, the efficiency of the plant, that is, the daily or weekly or monthly efficiency, will be better in running the boilers in that way; and at present the modern practice tends to run the boilers during peak loads at double the so called rate of 10 square feet of grate area per horsepower, and putting in boilers that will come up to that class of service, and the whole tendency is to drive the boilers even harder during that period, and I would not be surprised to see them driven considerably harder than that during these peak-load periods, with a gain in the efficiency of the plant as a whole. That does not apply to a plant where you have a nearly steady load, like a cotton mill or some load of that character. In that case we have a different proposition, and as we go deeper into the matter we appreciate the fact that a certain boiler arrangement that will apply in one case will not fit into another, and you have to study the conditions of the particular

plant from which you desire to get the best results.

H. C. Abell: There is one other point not brought out forcibly enough, and that is the hydrocarbons not being properly burned. Fifty per cent. of free air will give you about 240 cubic feet of gaseous products of combustion. Assuming the 15,000 B.t.u. per pound Professor Kent was speaking of, and assuming that only 1½ cubic feet of marsh gas is given off, which gives less than 0.7 of 1 per cent., we have 10 per cent. less in thermal efficiency—1500 B.t.u. escape in the 1½ cubic feet of marsh gas. In some of the boiler efficiencies I have followed up I have made tests by following the Orsat apparatus with an explosion pipette, and I have found a large per cent. of the efficiency lost and unaccounted for was due to the unconsumed hydrocarbons, and I think that occasionally the flue-gas analysis should be continued through to the explosion pipette.

Professor Kent: I used the explosion pipettes a good deal and the results were negative and I could not tell whether I had any hydrocarbons or not. I have my doubt about their use, unless they are used in connection with more refined analysis.

John C. Parker: I called up a power house yesterday, where they burn about 200 tons of coal a day, and I said, "Have you a CO_2 recorder?" The answer came "Yes." "Are you using it?" "No." "How long since you used it?" "Four months." "What is the matter?" "Needs repairs." "Anything else?" "Yes, I have to give it my personal attention." As far as I have had experience in going through the power stations of the country, I have usually found the recorders out of service; they tested them and then removed them. The CO_2 recorder is an interesting device; it is very clever, but it is more of a laboratory device than it is an instrument for the boiler room. It seems to me that, so far as I am personally concerned, if I can get control of the fire, get control of the grate so that I can burn the fuel, and if I can have some method of knowing just how much steam output I am making, I do not care whether the temperature of the fire is high or low, the CO_2 high or low, or anything else—all I want to do is to produce a large amount of steam with a small amount of coal.

We ran an 88-hour test recently, different grades of work, and we were surprised to find on the single-ended test, where there was undoubtedly more surface air than with the double-ended test, that the efficiency was higher. I have heard it stated quite frequently that a high CO_2 does not mean a high efficiency, and my experience justifies that view. Mr. Uehling says: "Air infiltration lowers the stack temperature in proportion to its ratio to the actual products of combustion." In one of my first boilers I varied the amount of air above the grate, and as I admitted more air my stack temperature went up. Of course, if you let enough air come in you can undoubtedly reduce your stack temperature. On one test I was taking the flue-temperature readings, and I watched the pyrometer from the time the man covered the fires until he covered them the next time—I wanted to find the difference in the flue temperature, the effect of different periods between the firing. I told him not to fire until I gave him instructions, and I watched the pyrometer for a half hour, and the flue temperature kept going up for a half hour. I got tired then and went to look at the fire, and it was burned out and was all ashes.

A. W. K. Billings: I do not think we should lose sight of the fact that what we are after is not efficiency in combustion but economy in the total operation of the plant. With chain grates it is possible to get high CO_2, and yet if you continue to operate them you will have increased maintenance expense and difficulties generally that will offset the ostensible gain in fuel. The fact that CO_2 recorders in general are insufficient to bring economy has come to my attention in my work, in which we have to deal with low-grade firemen and in which the cost of fuel is expensive.

I have been struck with the facility with which a fireman can beat the recorder. The percentage of CO_2 rises to a maximum and drops off when you get imperfect combustion. When the men are not subject to close supervision, the firemen, by unduly thickening the fuel bed and shutting off the draft, can shirk the work and force the load on other firemen and get a high CO_2 record, but at the expense of clinker troubles and other troubles generally.

I have noticed, especially in the case of large and important plants, that their experience with CO_2 recorders was a good deal such as I had on one occasion when I visited one of the largest and most efficiently operated plants in the United States. I was interested in a certain type of recorder, which I understood they used, and I asked where it was. They led me to a certain aisle where it was supposed to be, and it was not there. We asked the foreman where it was, and we went up another aisle and found one-half of it. It was not accomplishing the purpose for which it was designed.

There is a tacit assumption in this discussion that we must confine ourselves to the CO_2 in determining the efficiency of a plant. I think that is an error. The small fractional differences of boiler pressure show a more practical means of checking the performance of the boiler, and after all it is necessary to make a practical study of how you want your firemen to fire and how the details of the plant shall be handled. It is immaterial whether we observe the CO_2 or adopt other means of watching how the firemen handle the fire.

Under conditions which precluded other successful methods of determining the efficiency of the plant, I have tried the plan of taking the difference in air pressure through the fuel bed, and the difference in air pressure through the passages, taking a simple device, such as a Bristol recording instrument, to show that ratio. I have found that it could be developed into something that would be a very practicable means of watching efficiency, because it gives instantaneous readings and the apparatus is simple.

There is another point to be dwelt upon in watching fuel economy, by using a mechanical device which will tell what the fireman does—a point seldom mentioned—and that is under uniform conditions of regular tests, the gas analysis may be correct, but no matter how correct the analysis, if you have theoretical conditions, there is an error which may enter the calculations, and that is the time element. A continuous sample may not be representative of the average of the gas, which is the true measure of the losses, and while under normal conditions that amounts to little, under many conditions it can amount to 10 or 15 per cent. of the loss.

The paper of E. Viola upon the automatic control of condensing water related principally to the use of condensers in connection with vacuum pans for sugar manufacturing, etc. The discussion evolved nothing of interest to power-plant engineers. An abstract of the paper will appear in an early issue.

The paper upon a "Test of a 10,000-Kilowatt Steam Turbine," by S. L. Napthaly, and upon the "Test of a 9000-Kilowatt Turbine Generator Set," by F. H. Varney, were discussed together.

Discussion on Turbine Papers

An abstract of Mr. Varney's paper was published in the December 13 number, page 2206, and a review of the paper by Mr. Naphtaly appears in this number, page 2221. The discussion on both papers follows:

J. H. Lawrence: Mr. Naphtaly gives a table which is a summary of the tests made on the 10-000-kilowatt unit; one column is headed B.t.u. per kilowatt-hour.* His results vary considerably from those which I have calculated, and give the turbine a much lower heat consumption than I think it should be credited with. I have tried various methods and have used both the old and the new steam tables, but have not been able to check the figures given in the table.

The heat consumption of a turbine is the difference between the heat content

*For the table see page 2221 of this number. The column on B.t.u. per kilowatt-hour was omitted, but is reproduced in the accompanying table.

of the entering steam and the heat of the liquid in the exhaust steam, multiplied by the pounds of steam per kilowatt-hour. Accordingly, for run B with 168 pounds gage pressure, 59 degrees superheat, 28.18 inches vacuum and 14.427 pounds of steam, a heat consumption of (1232.7 — 66.1) 14.427 or 16,830 B.t.u. per kilowatt-hour is obtained. This result is almost 12 per cent. higher than that given by Mr. Naphtaly. The corresponding thermal efficiency is 20.27 and not 22.65 per cent.

Mr. Naphtaly's figures for Rankine cycle ratio check very closely with those which I have calculated.

The following is a table showing the revised results, calculated with the Marks & Davis tables:

The engineers of the Pacific Gas and Electric Company are to be congratulated on the speed with which a 9000-kilowatt steam-generating station was completely built and also on the very low kilowatt cost of this station.

It is interesting to note that on the test the water rate of the turbine was inside the manufacturer's guarantee, but it seems to me that this actual performance was not especially creditable to the Curtis turbine of 9000 kilowatts maximum capacity. Of course, the vacuum during the test was not especially good and with injection water of 51 to 52 degrees it should be possible to reduce the absolute back pressure by about one inch, which would very much improve the water rate of the turbine.

REVISED SUMMARY OF TESTS ON 10,000-KILOWATT TURBINE.

	Load, Kw.	Steam Pressure, Lb. Gage.	Superheat, Deg. F.	Vacuum, 30" Bar.	Water per Kw.-hour.	B.t.u. per Kw.-hour.	B.t.u. per Kw.-hour from Naphtaly Table.	Rankine Cycle Ratio.	Thermal Efficiency, Per Cent.
A ...	7,972	171	58	28.28	14.581	17,035	15,378	66.8	20.04
B ...	8,563	168	59	28.18	14.427	16,830	15,062	68.2	20.27
C ...	8,198	169	60	28.10	14.596	17,017	15,414	67.6	20.05
D ...	9,173	167	59	27.90	14.572	16,926	15,360	68.9	20.15
E ...	5,333	173	54	28.34	15.655	18,274	16,493	61.8	18.67
F ...	8,148	167	60	26.16	15.855	18,093	16,782	69.5	18.86
G ...	5,401	174	56	26.16	17.611	20,075	18,587	62.2	16.99

Dr. D. S. Jacobus: I wish that some of the gas-engine men would get onto their feet and say how much better they could do on the B.t.u. consumption. I have not checked up these B.t.u. figures myself, but he may have had a heater in his exhaust, and possibly done something there—I am not sure of that, but the figures as given here take about 15,000 B.t.u. per kilowatt-hour as they stand in the table, and one test would correspond with a boiler efficiency of 70 per cent. to about 22,000 B.t.u. per kilowatt-hour, which is a very low figure. The lowest figure for actual work, day after day, is that at Oakland, where, with an oil plant, the record was made of a kilowatt-hour for 25,000 B.t.u., including everything else about the plant. It would be interesting to hear some of the gas-engine men say how close they could get to these two figures—first, 22,000 B.t.u. for a steady load, and, secondly, 25,000 B.t.u. with a curve in which the load fluctuated greatly, and where there was a layover of 4.5 hours per day, and where the 25,000 B.t.u. included everything about the plant, such as the lighting, and represented the B.t.u. in the oil as compared with the net kilowatt output of the plant, and as paid for by the consumer.

Irving E. Moulthrop: Referring to Mr. Varney's paper, it is interesting to note that the steam turbine has operated satisfactorily when paralleled with a large number of water-power stations, and its service has been more satisfactory in regulation and maintenance than that from either steam engine or gas engine.

The superheat of 70 to 75 degrees on the maximum-load test is also rather low for the best results. One hundred and fifty degrees is safe for superheaters and piping from our experience and would better the economy some 6 per cent.

Both of these changes would probably have increased the investment. A gain of about 1¼ pounds in the water rate per kilowatt-hour would seem to be easily obtainable and would justify quite an investment charge.

Type	G. E. Vertical	West. Double-flow	G. E. Vertical	G. E. Vertical
Company	Pacific G. & E.	City Elec. Co.	N. Y. Edison	Boston
Station	Oakland	San Francisco	New York	L Street
Capacity of unit maximum	9,000 kw.			
Capacity of unit normal		10,000 kw.	8,000 kw.	5,000 kw.
Corrections for pressure, 1 per cent. for every	10 pounds	20 pounds		10 pounds
Superheat, 1 per cent. for every	12½ deg.	10 deg.	12 deg.	12 deg.
Vacuum per inch, normal load	1.8 pounds	0.45 pound	0.985 pound	1.15 pounds
one-half load		0.91 pound	1.35 pounds	1.60 pounds

Mr. Naphtaly has contributed some very valuable data upon the Westinghouse double-flow turbine, a type of machine about which very little information has been published. The unit is large, having a normal rating of 10,000 kilowatts and an overload capacity of 50 per cent. As the rise of temperature on the generator is only 60 degrees Centigrade after twenty-four hours of 50 per cent. overload, this unit might be given a rating of 15,000 kilowatts maximum.

It seems from the test that this unit is very efficient, especially at the low superheat and vacuum used.

It is interesting at this time to call attention to a test of a 3500-kilowatt horizontal Curtis turbine in a plant of the Great Western Power Company at Oakland. At 3464 kilowatts load, 194.35 pounds pressure at boilers, 127.5 degrees superheat, 1.17 absolute back pressure, inches mercury, the water rate was 13.62 pounds per kilowatt-hour. For the size of the unit this seems very good.

At the L street station of the Boston Edison Company, a 5000-kilowatt five-stage, Curtis turbo-unit tested in 1907 shows the following results:

Load, kilowatts	2,558	5,195	7,526
Steam pressure, lb.	173.0	173.7	169.7
Superheat, degrees Fahrenheit	149	142	134
Absolute back pressure, inches Hg	1.13	1.18	1.35
Pounds water per kilowatt-hour	15.24	13.57	13.73

This same machine has been tested once a month since being installed and the best record of actual water rate came with the highest superheat and the best vacuum: 5095 kilowatts, 170.4 pounds steam pressure at throttle, 179.1 degrees superheat, 0.52 inch back pressure, Hg., 12.71 pounds water per kilowatt-hour. The corrected economy to standard conditions of this test is slightly poorer than in the test given in the table above, so any possible error in this test is in the direction of making the water rate too high rather than too low. These figures seem to show conclusively the advantage of high superheat and vacuum, at least on the impulse type of turbine.

A glance at the correction figures used with the various units spoken of is most interesting, as they suggest the possibilities of the various kinds of turbines under different conditions of superheat and vacuum:

These figures would indicate that the impulse turbine received more benefit from an increased pressure than the combined impulse-reaction machine, which is very curious, to say the least, as the high-pressure elements are of the same type. The benefit from an increase in superheat is marked in both the types, with the advantage slightly in favor of the double-flow type. The benefit from an increase in vacuum is very much less in the double-flow combined impulse-reaction turbine than in the straight impulse turbine, especially at the heavier loads (42 per cent. as much at full

load, and 62 per cent. at one-half load).

The designer should provide for moderately high superheat and as good a vacuum as the inlet-water temperature will warrant, and then the operating engineer should continually keep after the condensing apparatus in order to get every bit of vacuum obtainable with the apparatus furnished him. This is true of both types of turbines discussed but especially true of the straight-impulse turbine.

George A. Orrok, of the New York Edison Company, presented the accompanying table in which are the results recalculated on the same basis of tests which have been available during the last few years, using the new Marks & Davis steam tables. The Rankine cycle efficiencies are neglected since in most cases the efficiency of the generator and the mechanical efficiency of the turbine are not given and cannot be easily obtained.

It is much simpler to compare the various machines on the basis of the B.t.u. in the steam at the throttle valve, and to credit the turbine with that portion of the heat turned back into the feedwater system at the condenser temperature.

The table gives actual test results, pounds of steam per kilowatt-hour, vacuum, superheat and steam pressure not corrected to the contract conditions.

He regretted not having at his disposal the latest Parsons performance in England, nor the latest A. E. G. performance on its 12,000-kilovolt-ampere machine, which it is reported is much better than any of the figures given. There is no doubt that from the larger-sized apparatus better results are being obtained.

ECONOMY TESTS OF STEAM TURBINES.

Turbine.	Load Kilowatt.	Steam Pressure, Pounds Absolute.	Superheat of	Vacuum.	Pounds Steam per Kw.-hr.	B.t.u. per Kilowatt.
Rummelsburg A. E. G.	4,179.6	179	289.3	29.19	11.95	15,665
Carville Parsons	5,164.1	207	125.2	29	13.15	16,122
Chicago Curtis	10,816	190	147	29.47	12.9	16,206
Berlin Moabit A. E. G.	3,150	185	225	28.5	13	16,352
Boston Curtis	5,195	179.5	142	28.8	13.52	16,578
City Electric San Francisco Westinghouse	8,563	183	59	28.18	14.427	16,850
N. Y. E. Westinghouse	9,830	192.2	96	27.31	15.15	17,778
Brown Boveri Rheinisch Westfall	5,128	176	193.7	28.47	14.32	17,790
N. Y. E. Curtis	8,880	192.5	108.5	28.1	15.05	17,940
Pacific Curtis Oakland	8,775	194	72.95	28.03	15.95	18,735

E. D. Dreyfus: In the days of the Corliss engine, much interest was centered about discussion of initial condensation, cylinder ratios, jacketing, reheating receivers and other features affecting steam economy. The experience obtained from over 2000 steam turbines in service should now reveal the operating conditions and design which realize the highest final efficiencies. Uniformity of operating conditions has already become evidently, and very probably a generally accepted type will be prevalent eventually.

The author is to be commended both for having selected moderate working conditions by means of which he obtains the highest ultimate economy and for having indorsed an increase in rotative speeds which obviously conduces to higher efficiencies.

While the water rates which Mr. Napthaly obtained with his turbine (14.57 pounds as tested, and 13.88 pounds corrected) somewhat exceed other steam consumptions that have been recorded, there has, nevertheless, been established a new mark in the efficiency of conversion of the available thermal energy between the throttle and exhaust pressures into electrical energy at the switchboard; viz., 69 per cent. as referred to the Rankine cycle.

Until the turbine came to be extensively used, the Rankine cycle measurement of efficiency was but seldom employed in general practice. This may be ascribed to the fact that the efficiency of the compound or triple-expansion reciprocating engine does not improve proportionately with the amount of added energy made available by the higher vacua and superheats. Manifestly high vacua, so beneficial in the turbine art today, were not regarded seriously in reciprocating-engine practice. With many of us, the value of these factors has been insufficiently considered, and therefore greater familiarity with the temperature diagram is desirable. Such diagrams were formerly used in the critical analysis of steam-engine indicator cards, but they will in this case forcibly emphasize the influence of operating conditions. For example, with initial conditions of 190 pounds and 100 degrees Fahrenheit superheat, a one-half pound reduction in pressure at the exhaust end (from 28 to 29 inches vacuum) increases the available energy as much as the addition of over 100 pounds at the inlet of the first stage. This, of course, is of purely academic interest. In practice, the addition of an equivalent amount of energy would be made available by a further increase of 140 degrees Fahrenheit, or 240 degrees total.

Doubling the rotative speed reduces the steam consumption from 4 to 6 per cent., depending upon size. In 1000-kilowatt turbines of 3600 and 1800 revolutions per minute, under United States Government test, a difference of 4.5 per cent. was shown. Large turbines, such as those under discussion, would probably improve somewhat more.

The above efficiency, as already stated, has not been equaled in any other published test. It is to be remembered that this percentage includes all armature and windage losses of the generator, as well as the field losses which are commonly omitted.

It is believed that the efficiency ratio consistently improves until 100 degrees (Fahrenheit) superheating is exceeded, when further delay of the "dew point" or occurrence of saturation is offset by the greater amount of heat in a pound of steam passing out to the exhaust. Hence it is not improbable that the turbine would have accomplished a slightly better record with additional superheating—60 degrees being the average throughout the test.

The effect of vacuum is more indefinite and is subject to the areas and angles provided in the final stages of the turbine.

It is sometimes indiscriminately stated that the higher the vacuum the better the over-all plant results. This is plainly a narrow perspective, as the power consumption of the condenser auxiliaries is thus entirely ignored. Condenser temperatures fall off very rapidly with the increase of vacuum, as is shown by the standard steam tables, and the corresponding capacity and power required by the air and circulating pumps become proportionately greater. There is, consequently, a point where the improvement in the turbine fails to exceed the increased power demanded by the auxiliaries, and in the latitudes we are accustomed to we generally find the most economical yearly average vacuum varies between 28 and 28.5 inches (referred to 30 inches barometer), depending upon the source of water supply. While fuel economy is an important factor of the total cost of power, manifestly investment and operating expenses must also be reckoned with. Fortunately I have been able to obtain what I believe may be considered conservative installation and monthly operating costs from Mr. Napthaly's plant. These results plainly indicate efficient management, both in its construction and subsequent operation. The entire station consists of two 2500-kilowatt, and one 6000-kilowatt turbine, in addition to the 10,000-kilowatt unit.

A typical monthly payroll was $3565. Oil, waste, supplies, water and maintenance material averaged for three months, $769. The corresponding oil-fuel consumption was 20,800 barrels for the entire station, and the output was 4,908,800 kilowatts. The smaller units increase the amount of wages, and therefore only three-fourths, or less, is strictly chargeable on the basis of the use of large units.

Considering the new addition provided by the installation of the 10,000-kilowatt turbine which has been described, the cost to the City Electric Company may be conservatively quoted at $339,413, or $33.94 per kilowatt, including building, foundations, boilers, piping conduits, oil storage and burning equipment, auxiliaries and electrical apparatus—in fact, everything from the cost of real estate up to and including the switching gear.

The low total cost of a complete expansion turbine (less investment and cost of labor), it is believed, settles the question definitely as to the advisability of introducing a combined engine-turbine unit in a new station to accomplish a small saving in fuel. By employing the higher speed of 1800 revolutions per minute instead of 900, the unit has been reduced in length about 17 per cent. Mr. Napthaly developed his plans providing for two rows of turbines in the engine room, having them alternately faced with respect to one another. The 10,000-kilowatt turbines of the type described demand an engine-room floor space of only 0.18 square feet per kilowatt of normal capacity installed, which figure, it is thought, also constitutes a new record.

I am somewhat at variance in opinion with Mr. Moultrop on the advantage of vacuum. Every type of machine may be designed for the same degree of efficiency with a given vacuum. The change in economy of any particular type, with the change of vacuum, depends on the number of stages or rows of blades which it contains—therefore the machine with the fewer rows of stages is more sensitive to changes under operating conditions and will more rapidly decline in efficiency, if the auxiliary station equipment is not maintained up to the original standard.

As regards the question asked by Professor Jacobus, in relation to the gas engine, the large gas engine would not be a competitor for the large steam turbine. When you come to the smaller sizes, where the gas engine maintains its efficiency and the turbine falls off, there is a field for the gas engine.

Francis Hodgkinson: I had the pleasure of being present at the time this test was made, and while it is true that this was not a scientific test, in the sense that losses were all segregated, and that sort of thing, I do wish to state there was not a stone left unturned to insure its accuracy. I am in thorough accord with Mr. Moultrop when he says that it is unfortunate that the load conditions of the plant were such that they could not go to the heavy overloads, as the paper would then be of greater interest.

Mr. Moultrop quoted a number of tests, in which he showed some figures of steam consumption. We know that the pounds of steam per hour is not the whole thing. You must look at the whole thing, and consider the operating conditions. Mr. Jacobus brought out the fact that high superheat costs money to get, and is not an unmixed blessing. In the table in the paper is a column showing the Rankine cycle efficiency, for efficiency ratio. That is, after all, the best comparison we have, but it is not necessarily an absolute one. One turbine may be designed for a 26-inch vacuum and show a certain efficiency, and another turbine may be designed for a 29-inch vacuum and show another efficiency, and because the turbine with the 29-inch vacuum shows the lower figure, it does not follow necessarily that it is the worse turbine.

R. J. F. Pigott: In regard to turbine tests of recent years, it is a happy thing that manufacturers and owners of these machines are coming to feel that they can publish more data than we had several years before, but it is not an unmixed blessing, because most of them, while they probably take a great deal of pains in getting their data, they know it so well that they forget to put it in the papers, and the papers lack any data from which the readers can compute what they desire to know. This paper is open to that fault, I think.

The trouble which the other gentlemen found, I also found, in checking from the B.t.u. values. There is nothing in the paper which would guide one to a knowledge of how the B.t.u. value was computed, and this tends to throw doubt on the paper.

Mr. Naphtaly refers to the turbines at Fifty-ninth street, and states: "It is acknowledged that slightly superior efficiency exists with the combined engine and turbine unit, reported by Mr. Stott, at 72 per cent., the engine unit particularly making a remarkable showing. On the heat-consumption basis, however, the San Francisco unit is approximately only 3½ per cent. in excess of the combined reciprocating and turbine unit, but it is obvious that this advantage in steam consumption is offset by the advantage of the simple turbine unit, without the complication of the reciprocating engine, which involves greater first cost, greater floor space and cost of maintenance and necessitates shutting down the unit while the reciprocator is being adjusted, or else further complicating the system by use of an auxiliary governor and high-pressure valves on the low-pressure turbine." He is making his comparison, in his case, with 60 degrees superheat, and in the case of the turbines at Fifty-ninth street with saturated steam. If we compute the turbines at Fifty-ninth street with superheated steam, it would reduce the water rate from 13.2 to 12.3 pounds per kilowatt-hour. There is nothing to prevent the installing superheat and taking advantage of that. The real advantage of the low-pressure turbine, therefore, in this case is, as was stated in the paper by Mr. Stott, 13.5 instead of 8.5. Taking the lower figures, if the units are operated on normal load, it is about $70 or $90 a unit. The additional expense of more men to handle a turbine is about $8 a day, and the additional expense, based on the greater cost of the reciprocating unit over the turbine, is $12 a day, leaving a margin for taking care of additional repairs on the engine over what a turbine would be forced to have. These are based on a cost per kilowatt of from $83 to $100 for the engine system alone, the average figure being $85 to $90. In the case of some of the big plants, erected some years ago, it was $100. The low-pressure turbine costs $40 to $80 per kilowatt, which brings the average down to $65. The cost for the high-pressure varies from $65 to $68, so that the actual increase in cost, due to low-pressure turbine is not very great, and the interest is taken care of by the savings per day of 8.5 per cent. better economy. Mr. Naphtaly says: "But it is obvious the disadvantage in steam consumption is offset by the advantage of the simple turbine unit without the complication of the reciprocating engine." That statement is quite true in regard to new plants, because I do not think anybody is likely to design and build a large station having reciprocating engines and turbines. The high-pressure turbine has increased in economy too rapidly for that.

W. L. R. Emmet: Mr. Varney's paper relates to a machine of which a great many are installed and in operation, the five-stage Curtis turbine, operating at 750 revolutions per minute, and Mr. Naphtaly's paper relates to a newer development of the Westinghouse machine operating at 1800 revolutions per minute, the capacity of the higher-speed machine—the rating—being larger. The comparison will naturally be made by readers of these papers, who have heard them discussed together, as to the relative value of these units and the records in these papers look, upon inspection, very unfavorable to the Curtis unit. The results reported in Mr. Varney's paper are about a pound per kilowatt-hour worse than the results which Mr. Moultrop has reported on his Boston turbine, two or three of which have been tested with uniform results, and which are identical with the machine reported in Mr. Varney's paper. The machine in question had been in operation about a year when it was tested, and simply tested under station conditions, and the possibilities of considerable errors in such tests are very

well known. The other machine reported in Mr. Naphtaly's paper, I had occasion to study a little bit at the time of the Edison convention, because I saw the report submitted by the Westinghouse company to that association, about the same information which is contained in Mr. Naphtaly's paper.

Isaac Harter, Jr., presented some "Notes on the Value of Napier's Coefficient with Superheated Steam," which, with the discussion, will be treated in a later issue.

In lieu of the usual reception on Thursday evening, a reunion was held at the Hotel Astor on Wednesday evening. This is the principal opportunity afforded during the meeting for social intercourse, and its opportunities were enjoyed by a large proportion of the attending membership.

Thursday Sessions

On Thursday forenoon "A New Theory of Belt Driving" was presented by Selby Haar. "A Graphical Method for Calculating Stresses in a Connecting Rod," by Winslow H. Herschel, "Operating Conditions of Passenger Elevators," by Reginald P. Bolton, and "Modern Shoe Manufacture," by M. B. Kaven and J. B. Haddaway. In the afternoon the session in the auditorium was devoted to machine-shop practice, and the gas-engine section held a separate session in another hall.

Mrs. and Mr. Westinghouse received the members of the society and guests from 4 to 6 at the Hotel St. Regis.

Graphical Method for Calculating Stresses in Connecting Rod

W. H. Herschel called attention to the fact that while empirical formulas are sufficiently accurate for designing slow-speed engines, when it comes to high-speed engines other forces are involved which make the use of such formulas questionable. On the other hand, analytical formulas are unsatisfactory because they are, for the greater part, based upon incorrect assumptions.

To avoid the assumptions generally made in calculating stresses in a connecting rod by analytical formulas, a graphical method is proposed for finding the stress at any point of a rod of any shape. Determination of the inertia forces of material points is simplified by means of a diagram calculated from exact formulas. The bending moment due to inertia forces is calculated by the usual string-polygon method, and there is also a moment equal to the axial method, and a moment equal to the axial thrust multiplied by the sum of the deflection and an assumed eccentricity of loading. Deflections are found by Mohr's method and the eccentricity is assumed in accordance with the conclusions of Moncrieff.

The numerical examples show that in a simple shaft of uniform stress the maximum bending moment and maximum diameter will be less than 0.6 the length of the rod from the crosshead end, and the maximum bending moment at any one point will occur at about 38 per cent. stroke. The stresses are much greater than given by the usual formulas, mainly on account of considering the bending moment due to axial thrust.

Gas Power Section

The session of the Gas Power Section was held on Thursday afternoon, President Bibbins presiding. After listening to the president's address and the reports of the various committees the society proceeded to consider the papers. Two papers were presented, one on the "First Large Gas Engine Installation in American Steel Works," by E. F. Coleman, and the other, "Notes on a Large Gas Producer," by Nisbet Latta. An abstract of the former, with the discussion, will appear in a later issue, and the latter paper is presented in the Gas Power Department of this number. Owing to the untimely death of Mr. Coleman, his paper was abstracted and read by E. E. Kreiger. Also, Mr. Latta was prevented from being present and Mr. Lent presented an abstract of his paper.

In discussing Mr. Latta's paper, Mr. Chapman recalled the fact that he had visited the Hirt producer while it was in operation and had noticed that it emitted smoke which extended a distance of a quarter of a mile. He was of the opinion that a better analysis than those shown could be obtained by putting in less air, in which case the CO_2 would decrease; but when enough air was admitted to make a good commercial mixture, the CO_2 increased and the producer became more of a furnace. As for the statement that "a large producer is impracticable owing to the difficulty of its operation and the difficulty of stoking," Mr. Chapman contended that it applied only to hand-stoked producers, as the large ones must be stoked mechanically, and upon mechanical agitation with a deep fuel bed largely depends the elimination of blowholes having an intense temperature.

Mr. Winchop referred to the fact that the analyses given in the paper showed a low heat value of the gas for a high heat value of the coal, representing a rather low efficiency of the producer, the high temperature apparently working against a high efficiency.

At the conclusion of the discussion, the new president, Mr. Fernald, took the chair and after making a short address adjourned the meeting.

Friday was devoted to excursions to various points of engineering interest in the city and vicinity, a large number of which had been provided for the selection of the visitors.

Philadelphia Engineers Hold Banquet

The second grand concert, supper and dance of the Combined Associations of the National Association of Stationary Engineers of Philadelphia, Penn., was held at Lulu Temple on Tuesday evening, December 6. The combination included Quaker City No. 1, Tacony No. 9, Merrick No. 12 and Northeast No. 20. Notwithstanding the severe snow storm which prevailed, the large auditorium was well filled with the members and friends of the several organizations, many prominent personages of the engineering fraternity being present.

The festivities began with an enjoyable entertainment by the New York "Bunch," comprising Herbert Self, Peerless Rubber Manufacturing Company; Frank Corbett, Consolidated Safety Valve Company; Billy Murry, Joe McKenna, Johnny Forsman, James Devins, Jenkins Brothers; and Jack Armour, of Power. In an interval during the entertainment Past National President W. J. Reynolds called Past President Lynch to the stage and presented him with a handsome gold jewel. It is the intention of the national body to present to all of the living past presidents a similar emblem.

At the conclusion of the musical program the guests adjourned to the dining hall, where an appetizing dinner was served. Dancing followed the banquet.

The officers and representatives from the various associations acted as a general committee and they were congratulated upon the completeness of the arrangements.

They started Jones out from the terminal in front of fifty loads with No. 5637 and a lot of leaky tubes. Jones had reported 5637 the last time he took her out so he was wise to the reason for her poor steaming and kept her going as long as he could, but there was a limit and finally Jones wired in from tower "WR":

"X5637 died at WR; what shall I do? Jones."

The master mechanic replied:

"Was death sudden or lingering? Miles."

To which Jones responded:

"Lingering and long drawn out."

His reply from the master mechanic was:

"Come in. Inquest Thursday."

Sid Diggles hez a old yaller tom cat 'round his ingin room. It fell inter th' flywheel tother day an' after swingin' 'round th' circle a few times, flew out an' landed on th' bib uv Sid's overalls. Sid dubbled up like a jack knife an' cudn't get breth enuf t' cuss th' cat fer 'bout two hours; he's bin makin' up fer it ever since tho. He says it's th' wust catastrophe thet ever happened t' him in all uv his experience.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Annealing Brass

I wish to anneal the ends of some brass heater tubes before expanding them in place. How can I do it?

A. B.

It is customary in annealing brass and some other metals to heat to a dull red and cool in water. The result will be the same if allowed to cool slowly.

Effect of Extra Lap

If lap is added to a plain slide valve, will it be necessary to change the eccentric?

E. E. L.

To give full port opening the travel of the valve must be twice the width of one steam port plus twice the lap. If the travel of the valve with the added lap will not give full port opening, the throw of the eccentric should be increased.

Proper Position for Globe Valves

In putting globe valves in a horizontal pipe line, how should they be placed?

P. G. V.

Valves should always be placed as near the supply end of the line as is possible with the stem horizontal to avoid a possible water pocket and with the pressure under the disk, so that the valve may be closed and the stem packed while under pressure.

Method of Banking Fires

My fires are banked for about 14 hours. I close all doors and the damper, but sometimes the fire burns through and the safety valve blows. How can I prevent it?

M. B. F.

By opening the flue doors just enough to furnish what air leaks past the damper. In this way no air is drawn through the fire or ashpit doors.

Sulphur in Feed Water

Is water saturated with sulphur suitable for boiler-feed water?

S. F. W.

Sulphur is not soluble in water unless in chemical combination with some other element as iron or lime. With lime it forms scale and with iron it causes pitting and corrosion and is not desirable in feed water.

Difference in Tube Expanders

Is it good practice to use a tapered plug in expanding boiler tubes? Would not a roller expander be better?

D. T. E.

Good practice depends more on the manner in which any tool is used than upon the tool itself. The roller expander is convenient and more easily handled than the plain plug, but in the hands of a skilled mechanic the work done with either will be equally good.

Fusible Plug Composition

What composition is used in filling fusible plugs?

F. P. C.

Fusible plugs are or should be filled with pure tin which melts at 442 degrees Fahrenheit.

Position of Check Valve

Should the check valve in the feed pipe be placed between the boiler and the globe valve, or should the globe valve be next to the boiler?

P. C. V.

There should be a valve or cock between the check and the boiler which may be used if it becomes necessary to repair or replace the check.

Starting Cross-Compound Engine

If a cross-compound engine has no bypass to the receiver, how may it be started when the high-pressure side is on the center?

S. C. E.

By slightly opening the throttle and working the high-pressure wristplate by hand until there is pressure enough on the low-pressure piston to move the engine off the center.

Underground Pipe Covering

We have two lines of steam pipe, 400 feet long, at present laid underground in wooden box packed with shavings; this method is unsatisfactory as the shavings accumulate dampness, and the pipes decay from the outside. What do you think of laying the pipes in tile?

U. P. C.

The same practical common-sense methods should be observed in laying steam pipes underground as above. They should be protected by the most efficient nonconducting covering available and kept dry on the outside.

Water Temperatures in Engine Calculations

What five temperatures of water are often used in power-plant calculations?

T. E. C.

32 degrees, melting point of ice.

39.1 degrees, temperature of greatest density.

62 degrees, standard temperature.

70 degrees, standard temperature for condenser injection-water calculations.

212 degrees, boiling point at sea level.

Engine Duty Defined

What is meant by the term duty when applied to a steam engine?

E. D. D.

It is the work the engine is capable of doing on a given fuel or steam consumption. It is stated in pounds of fuel, combustible, or steam per indicated horsepower, or foot-pounds of work for a given number of pounds of steam, or of heat units supplied.

Direct and Indirect Engine

What is the difference between a direct and an indirect engine?

D. I. E.

An engine is direct when the motion of the valve coincides with that of the eccentric, and indirect when the motion imparted by the eccentric is reversed by the interposition of a rocker arm.

Open and Closed Feed Water Heaters

What is the difference between an open and a closed feed-water heater?

F. W. H.

In the open heater the water and the steam intermingle in the same chamber or vessel, which is open to the air, and from which the water flows to the pump by gravity.

In the closed heater the water and the steam are separate, the water usually passing through tubes which are surrounded by steam. The water is forced through the tubes on its way to the boiler by a pump or injector.

Blowback in Crane Pop Valve

How is the blowback in a Crane pop safety valve adjusted?

B. C. V.

It is not adjustable at all in the general acceptation of the term. The tension of the auxiliary spring which controls the degree of blowback is fixed at the factory and cannot be changed without dismantling the valve and changing the tension of the spring. The reduction in pressure before the valve closes will be the same regardless of the pressure at which it may be set to blow.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.
150 Michigan Avenue, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue 34,000 *copies are printed.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Please do not ask us to start subscriptions before the December 6 *issue. All previous issues are exhausted.*

Contents

	PAGE
Western Union Plant in Chicago	2216
The Steam Turbine in Germany	2218
Test of a 10,000-Kilowatt Turbine	2221
Boiler Tube Soot Blowers	2222
Uncle Pegleg's Philosophy	2226
Blowoff Valves of the Angle Type	2228
Lightning Investigations	2231
Electrical Restrictions in Cleveland	2231
Largest Electric Motor in the World	2231
Automatic Generator Motor	2231
Mr. Greer's Puzzling Converter Trouble	2231
Modifications of the Humphrey Pump	2233
Notes on a Large Gas Producer	2235
A New High Speed Diesel Engine	2237
Practical Letters: Home Study....Safety of Dished and Flanged Heads....A Hydrostatic Boiler Test....How to Make a Flash Boiler and Magneto....Correcting a Packing Trouble....Automatic Nonreturn Valves....Position of Blowoff Pipe....Lining Coal Chutes with Tile....A Homemade Friction Drive	2238-2240
Discussion Letters: Uncle Pegleg on Velocity....Central Station vs. Isolated Plant....Reverse Drive....Water in the Ashpit....Writers among Engineers....Treatment of Subordinates....Hotel Power Costs....An Engineer's View of "Graft"....Trouble with Metallic Packing....Furnace Design....Feeding Boilers	2241-2244
Annual Meeting of Mechanical Engineers	2245
Editorials	2255-2256

POWER and The Engineer

Editorial

Vacuum and Pressure

There is a great deal of looseness in the treatment of that subatmospheric pressure which is referred to by the engineer as a vacuum. Instead of expressing it directly in terms of the pressure existing in the vacuous space above absolute zero it is expressed in terms of the difference between the zero pressure and that of the atmosphere, as the hight of a column of mercury which will be sustained by the atmospheric pressure against the lower pressure in the vacuous space.

This would not be so bad if the atmospheric pressure were constant, but the barometer is subject to considerable variation even in the same location, and is very considerably affected by elevation.

Suppose an engine or a turbine to be designed to operate between 135 pounds absolute initial and 2 pounds absolute back pressure. If it is stated in this way there can be no misunderstanding. The pressure and temperature in the boiler or steam chest must be 135 pounds and 350 degrees, and the pressure and temperature in the condenser must be 2 pounds and 126 degrees, and this whether the plant is at Coney Island or on Pike's Peak.

The designer can determine how many heat units or foot-pounds of energy are available between these limits, and proportion his engine accordingly, and tests made under similar conditions so expressed would be comparable.

But suppose a specification or guarantee to be expressed in pounds gage for the initial pressure and inches of mercury for the vacuum.

For a gage pressure of 120 pounds there would be an absolute pressure of 135 pounds, in round numbers, at the sea level or with a 30-inch barometer; but for a barometric pressure of 27 inches the absolute pressure in the boiler would be only 133.5 pounds. This would knock off less than a degree of temperature and less than half a B.t.u. of total heat at the high-pressure end.

This is not serious, but on the low-pressure end the disturbance is worse. Two pounds absolute pressure means about 26 inches of vacuum with a 30-inch barometer, but with a 27-inch barometer a 26-inch vacuum means an absolute pressure of one inch of mercury, approximately half a pound, the temperature corresponding to which would be only 79 degrees instead of 126.

In other words, if the conditions are expressed, as is a common practice, as 120 pounds (gage) initial and 26 inches vacuum the temperature range with a 30-inch barometer will be from 350 to 126 = 224 degrees and the heat convertible into work by a perfect engine 274 B.t.u., while if the barometer is at 27 inches the temperature range will be from say 349 to 79, a difference of 270 degrees against 224, and the heat convertible into work by a perfect engine would be 348 B.t.u. against 274.

A low barometer is then an obvious advantage to the engine when the vacuum specified for it is expressed in inches of mercury. The expert who, holding a brief for the engine builder, waits for a high barometer with the idea that the engine will profit by the higher vacuum attainable fools himself, if that higher vacuum is produced by a higher atmospheric rather than a lower condenser pressure.

A vacuum of 26 inches with a 30-inch barometer is only 87 per cent. of the possible, and easily attainable. Its temperature with steam is 126 degrees and there is a wide difference between this and the temperature of available condensing water. A vacuum of 26 inches with a 27-inch barometer is 96 per cent. of the possible and the temperature of the vacuous space is with water vapor 79 degrees. There is a small difference of temperature between this and ordinarily obtainable condensing water, and the condenser man to meet this condition must furnish larger water pumps and air pumps which must be not only larger but more efficient.

Two practices have arisen, one of referring the vacuum to a 30-inch barometer and the other of expressing the vacuum in percentage of the possible, i.e., the obtained vacuum divided by the reading of the barometer. Neither of these solves the difficulty which is, however, completely disposed of by expressing the lower level in pounds absolute. The only disturbance which can come with this practice is that the air pump of a condenser designed to preserve this low pressure would have some less work to do with a low than with a high barometer, and for an abnormal case the barometric pressure expected could be worked into the specifications.

The Lap Seam Repeats

Another lap-seam boiler is added to the long list of those which have failed in Massachusetts where more time, effort and money have been spent to secure adequate boiler-inspection laws than in all of the other States combined.

In forbidding the installation of new boilers over 36 inches in diameter having lap-riveted longitudinal joints, a half step was made toward legislation for public safety, which, if completed by fixing a reasonable age at which all boilers of this type should be retired or have the allowable pressure so reduced that their operation for power purposes would be unprofitable, would spare many lives and save millions of dollars' worth of property. In this latest failure the old story of the hidden crack which can be found only by unmaking the seam is repeated, and one that will be told time and time again as these boilers one after another go to destruction.

The cause of the deterioration of the sheet just outside the outer row of rivets has been too often explained to need repetition. But the fact that all joints of this type are of uncertain strength and because of this uncertainty should be classed as unsafe cannot be too strongly emphasized.

Some years ago the idea was advanced that on account of the laminated structure of iron-boiler sheets it is difficult if not impossible for a surface crack to work its way entirely through the sheet, the crack being checked at the first lamination just as does the hole drilled stop the extension of a crack under other circumstances. Until recently the iron boiler has been immune from this kind of failure. But the Laconia boiler was of iron and the small size of the sheets in the New Bedford boiler indicates that it antedated the beginning of the period of the general use of steel for boiler plates.

Whether of iron or steel the final result of the flexure which takes place at every change in pressure will be the same. Failure is inevitable. Almost without exception the recent disastrous explosions have been in this type of boiler, many of them subject to the best obtainable inspection and high-grade, skilled attendance.

Massachusetts has taken advanced ground in the matter of boiler legislation and is to be commended for the good work done in the prevention of the perpetuation of the lap-seam boiler on the people of the Commonwealth. But it is regrettable that the hands of the Board of Boiler Rules have been tied to the extent that, although it may decide the eligibility of a new boiler for installation in the State, it may not forbid the use of one already installed on which an insurance company will take a risk. The lap seam has long been discarded in European boiler practice.

Good Machines and Good Men

When a man expends a certain amount of money for apparatus of any kind, it is generally done with the expectation of getting a machine that will make a saving over other types. Most men will pay a high price for good apparatus rather than a low price for an inefficient machine, because it is their expectation to more than save the extra cost of the better machine in operating expenses.

This is sound business sense, and the purchaser will not be disappointed if the machine is properly handled. There are cases, however, where high-grade machines are being operated in so ignorant or careless a manner that the results expected are not obtained.

In some cases perhaps the purchaser is influenced by a salesman into buying apparatus that is not suitable for the work, but even if a mistake has been made in the selection of machines, it is not good management to allow incompetent men to operate them just because they will work for a low wage. The saving in labor cost will never exceed the losses occasioned by inefficient management, such as is displayed in the following cases:

A certain manufacturing company installed a high-pressure boiler at a higher first cost than the same output could have been purchased in a low-pressure boiler. The idea was to carry a high steam pressure and attain a high efficiency in the engine.

An ordinary man, paid the usual low wage, was placed in charge of this boiler. In due time scale began to form in the tubes, and eventually they became so coated that some of them failed, and the plant was shut down until repairs were made.

Here was a high-priced boiler put out of commission and a manufacturing plant shut down because the man in charge failed to keep the tubes of the boiler clean. More than that the loss in heat transmission due to the accumulation of scale would doubtless more than cover the wage of the engineer.

In another steam plant a number of Corliss engines are installed. These engines are run seven days a week, day and night. There is no reserve unit, so that none of the engines can be shut down for repairs, and as a result the plant is in a deplorable condition. The pounding of the cranks in passing the centers is worse than might well be imagined and the wonder is that some of the crank pins have not been sheared before this. If the visible parts of the engine are so out of adjustment, what must be the condition of the valves?

Evidently there is no use of installing high-grade engines when so little attention is paid to their operation, either because provision has not been made for needed repairs and adjustments, or because an incompetent engineer is in charge. If economy is to be practised in one department of the power plant, it should be in all, and there is but little use in buying the best machines unless they are to be put in charge of competent men.

Boiler Explosions in Germany

"What man has done, man can do." The appalling number of boiler explosions constantly taking place in the United States may be ascribed by interested parties to the inherent depravity of inanimate objects. That, on the contrary, it is due to the inherent depravity of *animate* objects, is conclusively shown by comparison with the boiler-explosion statistics of Germany.

In the German Empire during the year 1909, there were only nine boiler explosions, six of which were attended by personal casualties. Altogether five persons were killed, eight seriously wounded and twenty-three slightly injured. Within the last thirty-three years there have been 518 explosions, by which 344 persons were killed, 211 severely and 509 slightly injured. By average, this is about ten explosions per year, killing ten persons, wounding six persons seriously and sixteen slightly. These figures are still more significant when analyzed, since in the recent years, when there must have been many more boilers in use, the actual number of disasters has run about the same, or even less, than in earlier years. The greatest number of explosions on the record is thirty-five, in 1894, and the highest account of deaths thirty-six, in 1879.

Of the nine explosions in 1909, five are believed to have been caused by low water; one by defective material; one by weakening of setting; one by corrosion, and one by breakage of a manhole bolt from too energetic use of the wrench, or otherwise. It does not appear that there was a water-tube boiler among them.

This is the season when the lecturer stands in the lantern's glare and descants upon everything from entropy to boiler-feed compounds for the benefit of the operating engineer. There is much to be gotten out of these lectures, and the opportunity to learn is not nullified by the fact that the lecturer may have as a motive the exploitation of his wares. One cannot know too much about the things he may be called upon to use, and discussion and a chance to hear the other man will bring out points about them that you never thought of.

The generally accepted belief in the safety of water-tube boilers seems to have received a severe jolt by the recent explosion in Brooklyn. The authors of textbooks upon boilers will have to get out revised editions.

Lap Seam Boiler Explosions

At 11 a.m., December 9, the 42-inch by 16-foot return-tubular boiler in the planing mill of A. S. Allen, on North Water street, New Bedford, Mass., exploded, probably fatally injuring Mr. Allen and seriously hurting and scalding six others. The rupture started in the longitudinal seam of the rear course, tearing the sheet completely from the rear head and from the course in front.

As the initial rupture was at one side and near the rear of the boiler, the reaction of the escaping steam and water threw the boiler whirling through the side of the mill into the street. In the fire which followed, the two-story building was practically destroyed. In a later issue particulars and illustrations will be given.

Another explosion of a return-tubular boiler, resulting in two deaths, occurred at Weatherby, Penn., on Monday night, December 12. The boiler was one of five owned by the Read & Lovatt Manufacturing Company. Particulars will be given in an early issue.

PERSONAL

It is understood that Max Rotter has severed his connection with the Allis-Chalmers Company to take charge of the new works which are being built at St. Louis for the manufacture of Diesel engines.

SOCIETY NOTES

The next annual meeting of the Indiana Engineering Society will be held January 12, 13 and 14, at Indianapolis, at the Denison hotel. The feature of the convention will be the annual exhibit for manufacturers of anything of interest to the engineering profession. Space for exhibit can be secured on application to the secretary, Union Trust building, Indianapolis, Ind.

BOOK RECEIVED

AN INTRODUCTION TO THERMODYNAMICS. By John Mills. Ginn & Co., New York. Cloth; 133 pages, 5¾x9 inches; 64 illustrations; tables; indexed. Price, $2.

STANDARD PRACTICAL PLUMBING. By R. M. Starbuck. The Norman W. Henley Publishing Company, New York. Cloth; 406 pages, 6x9 inches; 347 illustrations; indexed. Price, $3.

THE INDICATOR HANDBOOK. By Charles N. Pickworth. D. Van Nostrand Company, New York. Fourth edition; cloth; 142 pages, 4¾x7¼ inches; 93 illustrations; indexed. Price, $1.50.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

INTERNAL COMBUSTION ENGINE. Ernest Easthope, Jr., Vancouver, B. C., Canada. 976,858.

ROTARY EGINE. John Putnam, Peoria, Ill. 976,913.

WATER MOTOR. Henry W. Yost, Springfield, Ohio, assignor to the Yost Gearless Motor Company, Springfield, Ohio, a Corporation of Ohio. 976,972.

FLUID-PRESSURE MOTOR AND CONTROLLING MECHANISM THEREFOR. William H. Cahall, Chicago, Ill. 976,983.

ROTARY ENGINE. Harry A. Massey, East St. Louis, Ill., asignor of one-half to George H. Stein, St. Louis, Mo. 977,027.

TURBINE MOTOR. Thomas J. Loftus, Castella, Cal., assignor of one-half to Charles T. Loftus, Castella, Cal., and one-half to Harmon Bell, Oakland, Cal. 977,107.

ROTARY EXPLOSION MOTOR. Frederic Beck, Neuilly, France. 977,260.

ROTARY ENGINE. John Putnam, Peoria, Ill. 976,913.

INTERNAL COMBUSTION ENGINE. John Edward Sears, Jr., Newcastle-upon-Tyne, England. 977,334.

ROTARY ENGINE. John Putnam, Peoria, Ill. 976,913.

BOILERS, FURNACES AND GAS PRODUCERS

BOILER. Salvator Prebandier, Neuchatel, Switzerland. 976,912.

FURNACE FOR STEAM BOILERS. Francis Duffy, Chicago, Ill. 977,078.

BOILER CONSTRUCTION. Allison B. Stirling, Pleasant Mount, Penn. 977,144.

COMBINATION GAS AND OIL BURNER. Greene Allen Smith, Indianapolis, Ind. 977,231.

FURNACE. Burt L. Worthen, Tucson, Ariz. 977,249.

POWER PLANT AUXILIARIES AND APPLIANCES

GOVERNING MECHANISM FOR FLUID-PRESSURE ENGINES. Herbert H. Dow, Midland, Mich. 976,853.

VALVE. Thomas F. Payne, Pittsburg, Penn. 976,908.

CENTRIFUGAL PUMP. Ferdinand W. Krogh, San Francisco, Cal. 977,101.

VALVE. Henry Lippold, Erie, Penn., assignor to Lippold Valve Company, Erie, Penn., a Corporation of Pennsylvania. 977,105.

STEAM TRAP. Michael L. Richards, New Haven, Conn. 977,131.

TUBE-CLEANING APPARATUS. Clinton Robinett and John Patrick Reid, Dayton, Ohio, assignors to the Lagonda Manufacturing Company, Springfield, Ohio, a Corporation of Ohio. 977,223.

PIPE COUPLING. Frederick Sargent, Glencoe, Ill., assignor of one-half to Olafe E. Oleson, Chicago, Ill. 977,226.

FUEL MIXER. Alfred Schmidt, Lake Hopatcong, N. J. 977,229.

COMBINATION GAS AND OIL BURNER. Greene Allen Smith, Indianapolis, Ind. 977,231.

VALVE FITTING. Julius F. Bernstein, New York, N. Y., assignor to William J. Cunningham, New York, N. Y. 977,261.

BOILER FLUE. John Robert Crowley, Atlanta, Ga., assignor of one-half to Nathaniel Neims Boyden, Atlanta, Ga. 977,276.

DEVICE FOR HANDLING FLUE CLEANERS. Melville O. Lewis, Peoria, Ill. 977,411.

INDICATOR FOR INTERNAL COMBUSTION ENGINES. Edward D. Meier, New York, N. Y. 977,419.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC ARC LAMP. Willy Legel, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 977,022.

DYNAMO ELECTRIC MACHINE. William H. Powell, Norwood, Ohio, assignor to Allis-Chalmers Company, a Corporation of New Jersey, and the Bullock Electric Manufacturing Company, a Corporation of Ohio. 977,220.

ELECTRIC SWITCH. Percy L. Sibole, Wilkinsburg, Penn. 977,140.

OIL BREAK SWITCH. Harry J. Hunsicker, Albany, N. Y. 977,193.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

George Westinghouse, inventor of the air-brake, which practically revolutionized railroading, told the members of the American Society of Mechanical Engineers how he came to discover and perfect it.

It is a vivid picture for the man who says, "I've no time to read technical papers." It's a lesson which teaches that the *value* exists in technical papers, and whether it's extracted or not, depends wholly upon the reader.

How he conceived and developed the air-brake now in use on all railroads was told by Mr. Westinghouse in detail. Its conception, his story revealed, resulted first from an accident and second from the chance that led two young women to canvass his subscription to an engineering magazine, in which was recited the use of compressed air in the driving of Mount Cenis tunnel.

The accident was a collision of two freight trains between Schenectady and Troy in 1866, which delayed for two hours a train in which Mr. Westinghouse was a passenger. Had the freight trains been equipped with brakes of sufficient power, thought Mr. Westinghouse, the collision, with its subsequent loss of time to him, could have been avoided, and immediately he set to work to develop such a brake.

An inventor named Ambler already had perfected a chain brake which was operated by the revolving of a windlass in the engine, the chain thus being taken up and the brake levers of each car thus operated. To Mr. Westinghouse came the idea of exchanging the windlass for a cylinder beneath the locomotive, the piston of which should be of extraordinary length and connected with Mr. Ambler's chain so that the drawing in of the piston by the application of steam from the locomotive would give a more accurate control of the brakes than was possible with the windlass device.

But experiments showed quickly that the piston could not be made long enough to operate the chain on more than four or five cars, and Mr. Westinghouse overcame this difficulty by placing a cylinder beneath each car with a flexible pipe connecting each one to the locomotive for its supply of steam. This effort failed because, even in warm weather, it was found impossible to transmit the steam. Then the young ladies called.

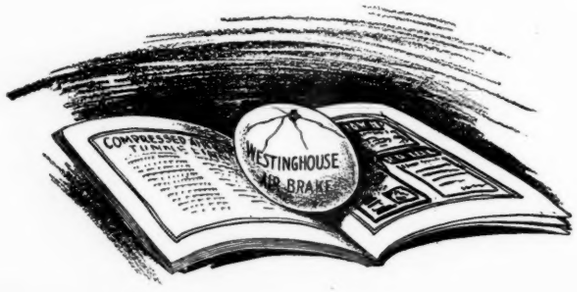
It was then that Mr. Westinghouse saw the article on compressed air, and in the use of this medium instantly saw a solution to his difficulties.

An apparatus employing compressed air instead of steam was built at once and a Steubenville, Ohio, accommodation train of the Panhandle railroad was equipped with the device. On its first test the engineer, as his train emerged from the tunnel near the Union Station in Pittsburg, saw a wagon on the tracks, and the value of the new brake was demonstrated instantly by the short distance in which the train was halted in time to avoid an accident.

Many experiments were made by various railroads, and in 1869 several of these had their running stock equipped with the new brake, but once more the inventor was to face and overcome an obstacle. It developed that it took too long to set and release the brakes, and that in the event of a break in the train the rear section would be without brakes. The first automatic air brake grew out of the need to provide against this contingency.

Of the lives which his brake may have saved in its prevention of railroad accidents, Mr. Westinghouse quoted a diplomat at the International Railway Congress in Washington in May, 1905, who declared that he felt safe in saying that "The air brake has saved more lives than any general ever lost in a great battle."

Mr. Westinghouse found the solution to his problem in the reading columns of an engineering paper.



Reading and advertising columns are twin brothers —the one tells "how," the other shows the devices which have been invented and marketed to help.

No progressive engineer can afford to overlook either any more than he can afford to cut out food and drink.